>>READ THIS ARTICLE AND KNOW MORE THAN 97% of the USUAL KOI FANATICS<<

Ya'll have gotten enough from me on the latest and greatest on the web site, so this time I am filling your in-box with an article on pH.

Do you know everything about pH?

Let's look at some terms:
pH - A rather abstract measurement of the amount of free 'Hydrogen ions' in the water. In perfect balance, the pH is 'neutral' and is reported as 7.0. An 'acid' pH (a lot of free Hydrogen ions) would be something like 5.0 or 6.0. An alkaline pH, with very little free Hydrogen) would be something like 9.0 - These hydrogen ions come from lots of places, but quite a contribution comes from Ammonia molecules as they are reduced to Nitrite.

NH3 → Activity of Nitrosomonas → NO2 (Hydrogens released, Oxygens required)

The significance of pH in the most general terms, is that your animals will die if they are exposed to a pH that is very low, or very very high. We will talk more about the behaviors of pH a little later.
Alkalinity - Amount of carbonate molecules in the water. See *carbonate activity*.
Total Alkalinity - Amount of carbonate molecules (activity) in the water.
Buffering Capacity - Carbonate (buffering) activity is exhaustible. When the carbonates are used up, the carbonate activity is gone. The capacity to stabilize pH is gone with it. If there's lots of Carbonates, the capacity to 'buffer' or stabilize pH is great. 'Buffering capacity' then refers to the amount of carbonate activity in terms of contribution to the 'neutralizing' capacity of the water. Examples in context include: "Wow, my water has almost no carbonate alkalinity/activity - I'll bet the buffering capacity is therefore pretty low. I can certainly expect pH fluctuations." OR: "Man, look at this Alkalinity! It's 200 ppm! My buffering capacity must be out the roof! My pH will remain rock solid."
Carbonate activity - is the action of the carbonate molecules. We will discuss the behavior of carbonate molecules so you can understand their importance in one moment.
Hardness - Is nothing but the mineral (Calcium and Magnesium) content in the water. Other minerals contribute to this number, but Calcium and Magnesium are the most prodigious contributors.
Softness: A term for water that is virtually free of minerals. A term which is irrelevant to pH.
GH - General Hardness - The Germans measure the water's buffering capacity in terms of "units of carbonate buffering capacity." General Hardness is a number which combines Hardness (mineral content) and Carbonate activity.
KH - Karbonate Hardness - Concurrent use of the word Hardness *with* Carbonate is actually a misnomer, since the conventional application of the word 'hardness' should only apply to the mineral content of the water. However, the KH is basically the GH (General Hardness) with the mineral number subtracted.

"How do I actually measure the PH and Total Alkalinity?"
There are several kinds of tests to measure pH. I use the drop-type test kits which use Bromthymol Blue dye as the reagent. I use the Aquarium Pharmaceuticals test kit for economy and accuracy. The test kit costs about five bucks. For a yellow result with the Bromothymol Blue dye as the reagent - we find the water to be 'acid' or low in pH. For a green result, we interpret neutrality, pH of about 7.0 and for a blue result, we interpret an Alkaline pH with a number over 8.0

The test for Total Alkalinity is available wherever human pool supplies are sold. There's even a cheap test kit which uses test strips and are readable in seconds. I found these at Home Depot in their pool supplies section. Kmart is also reputed to have these strip-type tests. A desirable result would be in the range of 80-150 ppm (parts-per-million) but numbers higher than that (to 300+) are also okay. I have seen illness in fish in very alkaline water, specifically a Total Alkalinity of over 400 ppm.

So we know that pH is an abstract measurement of Hydrogen ions in the water, and lots of these Hydrogens come from Ammonia reduction. Let's look at this dynamically.

An Ammonia-molecule is floating along when suddenly it is gripped firmly by its husk. A Nitrosomonas bacteria has it in it's clutches. With greedy, red eyes darting nervously back and forth, the Nitrosomonas bites deeply into the Ammonia molecule and rips off the three or four Hydrogen ions and discards them into the water. (At the same time, it grabs a couple Oxygens from nearby and screws them onto the Nitrogen to make a Nitrite, but that's a whole 'nother story.)

Those recently-cleaved hydrogens float along, and build up in the water to result in a lot of free Hydrogen in the water. This makes the water 'acid', and the pH to test low, like 6.0. This would be the natural state of affairs except for a rescue by Carbonate Activity.

Carbonate Activity is the activity of the 'carbonate molecule', which likes to act as a kind of "Federal Reserve Bank" for water. What this means in simple terms, is that when Hydrogen ions start to accumulate, the carbonates 'pick up the spares'. To the contrary, when the Hydrogen concentration is declining, the Carbonates can liberate some Hydrogens and keep the pH stable or unchanging.

"Where do Carbonates come from? "
Well, **Baking Soda** is nothing but Sodium Bicarbonate. When Baking Soda hits the water, it splits off the Sodium, and the carbonate is left. Addition of Baking Soda (Sodium Bicarbonate) results in a higher Carbonate Alkalinity but does nothing to Hardness.
Oyster Shell is nothing but Calcium Carbonate and Magnesium Carbonate. When the Oyster shell dissolves due to the presence of acid water, it liberates Calcium, Magnesium, and Carbonates. These mineral liberations increase the hardness of the water (contributing nothing to Buffering capacity) and the Carbonates increase the Alkalinity. Thus, the pH is stabilized.
Crushed Coral is Calcium Carbonate and Magnesium Carbonate but also contains a central structural molecule of Calcium Hydroxy-appetite. (I didn't name the stuff.) The significance of this is that when the crushed coral dissolves, it leaves behind the insoluble Calcium Hydroxy-appetite which is not a contributor to pH stability. While crushed oyster shell dissolves and vanishes, letting you know when to add more, the crushed coral remains, looking good but doing nothing.

"How do you use crushed oyster shell?"
Well, first, you have to realize it's not how much you use, but *how* you use it. If you put 300 pounds in a thousand-gallon pool, and run the water AROUND it, there will be no effect. I was reminded by Betty Roemer, that if you bag it and leave it on the bottom, there will form a slime layer on it which will also impede the dissolution of the particles. However, even five pounds of crushed oyster shell in a thousand-gallon pool will work wonders if ALL the water is forced through the bag in the filter. I had one customer fill a five-gallon bucket with oyster shell and supply it's own pump to it. Raised the water to 120ppm total Alkalinity almost overnight.
Powdered oyster shell is easier to use, although it clouds the water to a milky color initially during it's application. I use one cup per thousand gallons as a touch up to total alkalinity.

"If I understand correctly, it's possible to have hard acid water".
Sure, if you took distilled water, (which has nothing dissolved in it) and added Calcium Chloride, you'd get a real hard water without any contribution to total alkalinity.

"It's also possible to have soft alkaline water".
Sure, you could take the same distilled water, and add Sodium bicarbonate and get a pH of 8.3 and have no hardness at all. No hardness because there are no minerals.

"How do plants modify pH?"
Well, you'd have to understand in detail, how Carbon Dioxide usually behaves in water. [Which I don't]. All I know is that given the usually normal condition in the environment, every bit of Carbon Dioxide given off in water becomes Carbonic Acid, dragging down pH.
Recall that during the nighttime, the plants grow, taking oxygen and liberating carbon dioxide, which becomes carbonic acid, dropping the pH towards the acid range.

During daylight hours, plants reverse their respiration and give off oxygen taking in carbon dioxide. Without carbon dioxide around in the water to make carbonic acid, the pH rises into an alkaline condition.

"Why should I care about having an adequate Total (carbonate) Alkalinity?"
Well, the bacteria in your filter which are responsible for breaking down Ammonia won't function well at lower pH. In fact, these heterotrophs "shut down when the pH nears 5.5! If you're trying to bring a filer online and cycled as fast as possible, I must emphasize to you that warmth, oxygenation and support of carbonate alkalinity are the three key ingredients.

Water 'clarifies' better with higher Alkalinity. It's a simple fact that I can not correctly explain but has to do with settling out positively charged particulate debris (proteins, or nitrogen based molecules).

Fluctuations in pH will be minimized by carbonate buffering. A stressful or potentially fatal crash of the pH can be avoided by the reinforcement of carbonate buffering.

"What does this boil down to?"
1) pH should be neutral or pretty close to it. A high pH is not worth worrying about unless Ammonia is in the water. (But that's a whole 'nother story.) A low pH should be brought up right quick! Don't bring it up slowly or the fish can die while waiting for their rescue.
2) pH will fluctuate a lot if there's not a buffer to 'grab up' or 'give off' the Hydrogen molecules. Carbonates are needed for this reason. Supplementation of carbonates to the pond will raise the Total Alkalinity and stabilize the pH.
3) Carbonates can be supplied in the form of specialized powders from commercial sources such as SeaChem's Neutral Regulator (my fave) or from Crushed Oyster shell.
4) Your water will be clearer with a higher Total (carbonate) Alkalinity.
5) Hardness is not a measurement that can be associated with pH.

"What are my 'action items'?"
- ❑ Have a pH test kit and check your water at least weekly, if not more.
- ❑ Have a test kit for Total Alkalinity (pool supply store has these) and test after major water changes or anytime water is in question.
- ❑ Use a commercial buffer (baking soda or powdered oyster shell) to insulate yourself against losses due to pH crash.