

Koi Pond Water Quality

By Larry Lunsford - Rocky Mountain Koi Club

What To Test (Listed in order of Koi killed by failure to control parameter)

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|----------------|--------------|---------------|------------|
| 1. Chlorine | 2. Ammonia | 3. Alkalinity | 4. Nitrite |
| 5. Dirt | 6. Oxygen | 7. Copper | 8. Salt |
| 9. Temperature | 10. Hardness | 11. Nitrate | 12. pH |

Chlorine: Chlorine is used by water treatment plants to kill harmful bacteria. Chlorine is toxic to koi and must be removed from the water. Chlorine can be removed from the water by: aeration, filtration with carbon, or chemically neutralized with "de-chlor". If you are certain that your tap water concentration of chlorine is low and that its chlorine and NOT chloramine, then you can eliminate most of the chlorine with aeration - simply add new water to the pond by using a fine spray head on your hose. Activated carbon filters also work well to remove chlorine - be sure to check the water coming out of your filter to make sure the filter is not exhausted and allowing chlorine to pass through. Dechlor is the surest way to neutralize chlorine. You can make your own dechlor by mixing 8 ounces of sodium thiosulfate with 2 liters of water. Always test your pond for chlorine after adding water. Be alert to high levels of chlorine in the tap water in the spring and after rain storms. Also, if you see construction work in your neighborhood be alert - sometimes they will dump in a bunch of chlorine if they have to work on the water mains. Chlorine is easily detected using tests such as Aquarium Pharmaceuticals liquid drop test kit. The test should be crystal clear - if you even see a trace of yellow add dechlor and test again.

Alkalinity: Alkalinity (also known as carbonate hardness, KH) is a measure of the carbonates and bicarbonates in the water. Carbonates and bicarbonates act as a buffer. They will help raise the pH if other factors are bringing it down and they will help lower the pH when it is high. Carbonates and bicarbonates are also a vital part of the nitrification cycle - the bacteria require carbonates to function and they consume the carbonates from the water. You must replenish the carbonates to maintain a stable pond. In a concrete pond, the concrete will naturally leach out carbonates. In a rubber lined pond you will probably have to add carbonates to your water. You can control the alkalinity of your pond by adding baking soda. For testing, I prefer Tetra's total alkalinity test kit (it has a big KH on the box). I would suggest that you keep your alkalinity between 100 parts per million (ppm) and 150ppm. If you need to increase your alkalinity, use the following formula to determine the quantity of baking soda to use:

$$\text{ounces of baking soda} = \frac{\text{gallons} * \text{increase in alkalinity (ppm)}}{5000}$$

If your alkalinity is low (below around 80ppm) adding alkalinity will also raise the water's pH. Your bio-filter needs carbonates, but your bio-filter and fish also need a stable pH. If your alkalinity gets too low, stop feeding your fish, and slowly raise the alkalinity by 10ppm to 20ppm per day.

Ammonia: Ammonia (NH₄) is the primary waste product of koi. Ammonia is toxic to koi and must be neutralized, removed, or broken down into something else. Ammonia can be neutralized with chemicals such as Amquel. Amquel chemically binds up ammonia in a form that is not harmful to koi. Ammonia that is bound with chemical neutralizers will eventually be consumed by your bio-filter. Ammonia can be removed by using a filter containing Zeolite. There are thousands of varieties of zeolite and each type has its own characteristics - some are good for absorbing ammonia and some aren't. In my one experience with zeolite, it did nothing to remove ammonia so beware. Ammonia can also be handled by performing water changes. In a new pond or when adding fish to your existing pond,

you may need to perform water changes to keep the ammonia under control until your bio-filter can catch up. The best way to deal with ammonia is with a bio-filter. The only way to get a fully functioning bio-filter is to give your pond time. Aeration is good for your pond, but it won't directly eliminate ammonia.

There are two basic types of tests for ammonia - Nessler and salicylate. Salicylate kits produce results having colors between green and yellow. Nessler kits produce colors between clear and yellow. I prefer to use a Nessler kit such as Aquarium Pharmaceuticals liquid drop kit for a quick check. If it is absolutely clear, then you don't have any ammonia. If the test is the least bit yellow, then I prefer to use a liquid salicylate kit to get an accurate measure of the ammonia. Note: if you're using a chemical ammonia neutralizer, then you must use a salicylate kit - the Nessler kits react to the ammonia neutralizer.

Nitrite: Nitrite (NO_2) is produced by bacteria as they break down ammonia. Nitrite is also toxic to koi and you should try to keep the level near 0. The only ways to control nitrite is with a bio-filter or water changes. When your bio-filter is getting started, you will see the ammonia level rise then fall. As the ammonia falls, the nitrite will start to rise. In time, the nitrite level will decrease as the bio-filter matures. You can monitor nitrite with kits from companies such as Aqua. Pharm.

pH: pH is a measure of hydrogen ions. A pH of 7.0 indicates neutral water. Values below 7.0 are acidic (the lower the pH, the more acidic). Values above 7.0 are considered alkaline. Your koi can thrive in water with pH between around 6.0 and 9.0. More important than maintaining your pH in a specific range is keeping the pH stable. Your koi can acclimate to a wide range of pHs, but they get stressed by water with changing pH. Maintaining adequate buffering (see above section on alkalinity) will help keep your pH stable. One factor that upsets the pH is the bio-filter. Your bio-filter consumes carbonates and produces acid in the process of eating ammonia. Another factor that can cause pH swings is green water - algae. Algae produce oxygen and consume carbon dioxide during daylight hours. At night, the process reverses and algae produces carbon dioxide and consumes oxygen. Carbon dioxide in the water is acidic. Changing levels of carbon dioxide result in changing amounts of acid and changing pH. You can minimize problems associated with carbon dioxide by providing ample aeration (which causes the CO_2 to be released into the air) or by keeping algae growth to a minimum.

Temperature: Temperature affects the metabolism of koi, the bio-filter, and every other living thing in your pond. A temperature that changes too fast or too often can stress your koi. If you see that your pond's temperature changes by more than a few degrees a day, then you should consider taking steps to stabilize the temperature. You can stabilize the temperature in the summer with shade. In the winter you can cover your pond and bypass the waterfall to reduce heat loss. You should not let the winter water temperature drop below about 38°F - temperatures below this can cause permanent damage or death.

Nitrate: Nitrate (NO_3) is the final product of bacteria breaking down ammonia and is relatively harmless. Nitrate is consumed by plants and algae. Plants and routine water changes should keep nitrate levels to acceptable levels. You can easily check the nitrate level using a liquid drop kit that changes color to indicate nitrate level.

Salt: Salt is commonly used for treating koi. If you intend to use salt, you should only do so if you can accurately dose your pond. Too much salt is harmful and too little will not be effective. Aqua. Pharm. makes a kit for testing salt. LaMotte's salinity test kit can be used with Norm Meck's special instructions (come to the March meeting for details). I've seen instructions for modifying an inexpensive specific gravity meter that has a floating plastic pointer that indicates salt content, but I would not suggest using this method since it is not very accurate.

Hardness: Hardness is a measure of calcium and magnesium. The level of hardness is not critical - values between 20ppm and 200ppm are fine. High hardness can cause deposits of scale on your pond and pipes. High hardness is thought by some to cause freckles on koi.

Oxygen: Your koi need oxygen to survive, just like we do. If you have a waterfall, aren't over stocked and are moving your pond's water fast enough (once every two to three hours) then you don't need to worry about oxygen. Cold water holds more oxygen, warm holds less - also cold koi need less oxygen and warm koi need more. Algae produces oxygen during daylight, but consumes oxygen at night. The time to worry about oxygen is in the summer when the water is warm, your pond is green, and you have over stocked your pond. Koi gulping at the surface or hanging out by the waterfall are signs of low oxygen. Liquid test kits are available for testing oxygen, but I have not found them to be very useful - the color scale is difficult to use accurately. The only good way I have found to measure oxygen is with a digital meter (they cost around \$200).

Copper: Copper is very toxic to koi. Do not use copper in your pond. Copper plumbing in your house probably isn't a problem. You don't need to worry about copper unless the pH of your tap water is low (acidic) and you have copper plumbing. Acidic water can dissolve the copper in your pipes and allow it to contaminate your pond. If your tap water is acidic, test it for copper. If it tests positive, you can reduce the amount that gets into your pond by flushing your pipes thoroughly, and then filling your pond with the tap open wide - you want to minimize the time your acidic water is dissolving copper. Activated carbon also works well to filter copper from water. There are also filters made specifically for copper.

When To Test

Chlorine - every time you add water, hourly during major water changes.

Alkalinity - weekly in warm months, monthly in cold months.

Ammonia - daily for a new pond. Weekly once your bio-filter is up to speed. Daily after medicating your pond or after significantly increasing your koi population.

Nitrite - weekly for a new pond until the ammonia starts to go down, then daily until the nitrite has gone up then down. Weekly once your bio-filter is up to speed. Daily after medicating your pond.

pH - weekly. Monthly for a mature pond if your alkalinity is kept above 80ppm.

Temperature - four times a day a few times through the year. Look for temperature swings of more than a couple of degrees in a day.

Nitrate, Hardness - monthly first year, quarterly for a mature pond.

Salt - before adding more salt. After having added salt if your are the least bit unsure about your pond's volume.

Oxygen, Copper - not necessary under most circumstances.

Keep a close eye on your water after anything unusual (such as when you re-do your filter, your neighbor sprays his lawn, after you find a dead rat in the pond, etc.) You should also test your water whenever your koi are not acting normal. Don't assume that everything is ok.

Notes on Testing:

When performing water tests, you can get better results if you observe some good procedures. Keep your test vials clean. Dedicate specific test vials to specific tests to minimize contamination by chemicals from other tests. Clean vials immediately after use. View test vial in bright sun light against a white background. Hold dropper bottles vertically when dispensing chemicals and do not allow the

drop to come in contact with the vial until it has dropped from the dispenser. Make sure your chemicals and test sample are warm (cold water can inhibit chemical processes). Do not trust readings at ends of scale - if you are testing for XYZ and the kit has a scale of 1 to 5, do not trust a reading of 5. A reading at full scale means that the result is the maximum OR GREATER. Use fresh test kits. Liquid test kits usually have a shelf life of around one year, dry powers and tablets usually longer (check manufacturers recommendations for exact life). Keep tests cool and dry to extend life (don't keep them in a storage shed that is subject to extreme conditions). Check date on bottle before you buy - distributors and retailers don't always rotate their stock well. Many test chemicals are caustic and/or toxic - avoid contact with skin and eyes.