

Water Quality Consists of these Eight Important Components:

pH

The “H” in pH stands for Hydrogen and the “p” stands for potential or the power of that Hydrogen, the concentration of hydrogen ions in a solution. Hydrogen concentration is very important for living things because Hydrogen ions are positively charged and can alter the charge environment of other molecules in a solution by putting a force on the molecule causing it to dissolve into solution. A low pH value corresponds to a high hydrogen ion concentration and a high pH count corresponds to a low hydrogen ion concentration. A substance that increases the concentration of hydrogen ions (lowers the pH) is called an acid; and a substance that decreases the concentration of hydrogen ions (raises the pH) is called a base. There are also substances that enable solutions to resist pH changes when an acid or base is added. These substances are called buffers. Buffers help organisms maintain a relatively constant pH. Pure water is considered neutral with a pH of 7. Solutions with a pH less than 7 are said to be acidic and solutions with a pH greater than 7 are said to be basic or alkaline.

Tilapia prefers a pH range of 7-8, which is on the alkaline side of the scale. But most aquaponic farmers keep their pH levels between 6.8 and 7.0, which is a compromise for the fish and the plants as the plants prefer a more acidic environment. Drastic shifts in either direction can be lethal to both the fish and the plants. So watching pH levels is very important.

Ammonia Levels

All urine contains ammonia and tilapia urine is no exception. Some ammonia is even excreted through their gills. Ammonia also comes from the breakdown of their solid waste. In a lake or pond, the ammonia levels are of no concern because there is so much water compared to the number of fish. But in a tank, ammonia levels need to be carefully monitored because ammonia is toxic to the fish.

Bacteria and how they relate to Nitrite and Nitrate

There are actually three crops in an Aquaponic system: fish, plants, and the very important beneficial bacteria. It's the bacteria that convert the toxic components of the fish waste (ammonia) into a nutrient that the plants can use. There are actually several

types of bacteria living in an Aquaponic system; and each one performs a specific job. Without them, Aquaponic food production would not be possible. As an Aquaponic farmer, you have absolutely nothing to do with introducing, controlling or monitoring the bacteria. It all happens naturally, just as it should, as a part of the process of life itself.

Autotrophic Bacteria is a term that describes two function-specific bacteria. The first one, *Nitrosomonas*, uses oxygen to convert toxic ammonia into *Nitrite*; and the second one, *Nitrobacter*, converts *Nitrite* into *Nitrate*. Since both the ammonia and *Nitrite* are toxic to fish, these two bacteria are crucial to the system. *Nitrate*, being much less toxic than ammonia, can be tolerated by most cultured fish until it reaches very high levels. Once this autotrophic bacteria process is complete, the resulting *Nitrate* ions are controlled by the plants themselves.

Heterotrophic Bacteria is the term that describes how specific bacteria convert solid fish waste into ammonia and other elements. These two types of bacteria occur naturally. They inhabit the plant roots, the water, the tanks, the pipes and the media in an Aquaponic system. Their growth and density depends on the water temperature, pH, surface area, flow rate, and salinity (saltiness). Since the bacteria are not visible to the human eye, you can't measure or monitor them. So the only way you know your bacteria crop is a healthy one is through testing the levels of ammonia, *Nitrite*, and *Nitrate*, which you can do.

What happens when the Fish are introduced to the system?

The first thing that happens when you place the fish in the water is they continue their natural cycle of elimination of urine and solid waste and the ammonia level rises (for about the first 10 days). Then as the ammonia level starts to fall, the nitrite level elevates because *Nitrosomonas* bacteria have been busy converting ammonia to nitrite. They do this for another 10 days until you see the nitrite level start to fall and the nitrate level start to rise as *Nitrobacter* convert nitrite to nitrate. After 20-30 days, your system will stabilize and the nitrification cycle will proceed naturally indefinitely. At that point, your job as an Aquaponic farmer is to regularly monitor your ammonia, nitrite, and nitrate levels so you know your water quality is the best it can be for both your plants and fish.

Water Temperature

The ideal water temperature is a variable that depends entirely on what fish species and what plants you are growing. Tilapia thrive in temperatures between 70-85 F, but most Aquaponic farmers keep their tilapia tanks between 72-74 F, which is a

compromise between the fish temperature requirements and the plant requirements. Aquaponics is a multi-faceted system in which one component affects one or more other components. Water temperature is a cross-affecting component. It affects the oxygen levels, the amount of unionized ammonia (ammonia not yet converted to nitrite ions), and the amount of salinity (salt) in the water. Warm water has less oxygen than cold water. It also has a greater proportion of unionized ammonia and more salinity than colder water.

Water Oxygen

Even water life needs oxygen. In fact, the water oxygen level, called dissolved oxygen, is one of the most important water quality components in an Aquaponic system; and it needs to be monitored often. The best level of dissolved oxygen is about 80% saturation, which translates to 6-7 milligrams per liter (mg/l) or 6-7 ppm. Levels below 3 ppm are a hardship on aquatic life and levels under 1 milligram per liter are deadly. Both the time of day and the water temperature affect the dissolved oxygen levels. Cold water has more oxygen than warm water. The late afternoon is when dissolved oxygen levels are the highest and early morning (sunrise) is when they are the lowest. Even weather affects dissolved oxygen levels. Cloudy and/or rainy days cause them to go down. Too many fish in the tank can also deprive the fish of dissolved oxygen as well as too much food. If the water is saline, it also has less oxygen than fresh water has.

When your fish are oxygen deprived, they let you know by exhibiting the following traits: appetite loss, surface gasping, inflow pipe gathering, retarded growth, susceptibility to disease and succumbing to parasites.

There are two ways to test your oxygen levels. The cheap way involves an inexpensive Test Kit that gives you the DO (dissolved oxygen) level. It takes a little time and is not precise but gives you a ballpark number. Then there's the DO Meter, which costs anywhere from several hundred to a thousand dollars. It's fast and precise for a price.

Alkalinity

There is much confusion around the terms Alkalinity and pH as they are often mistaken for each other. They measure two different things which are related but not the same. Alkalinity is a measurement of water's ability to neutralize acids also called water's buffering ability so it refers to the ability of water to resist change in pH. These buffering materials are called bases and primarily include bicarbonate and carbonate. Water with low alkalinity is very susceptible to changes in pH. Water with

high alkalinity is able to resist major shifts in pH. Alkalinity is measured by titration. An acid of known strength (the titrant) is added to a sample of water. The volume of acid required to bring the sample to a specific pH level reflects the alkalinity of the sample as indicated by a color change. Alkalinity is expressed in mg/l of calcium carbonate. The acceptable level of alkalinity in aquaponics has a broad range between 50 and 300 mg/l.

Source of Water

Source may be last on this list; but it is by all means not least. When you place your Aquaponics system, the first thing you need to decide is where to put it. Now you may think that the second thing you need to do is fill it with water. But first, there's an important step. You need to know what's in your water before you expose either fish or plants to it. There are four possible sources for water: well water, municipal water, rain water, or water purified by reverse osmosis. You need to have your water tested by a laboratory that specializes in water for agricultural use to make sure it's not going harm your fish, vegetables, or bacteria. Ideally, it would be best to have this done while you're waiting for your complete, compact food-growing system to arrive. Your water should have a neutral pH of 7 or at least be in a range of 6-8. Well water can be superior to municipal water because it often has trace elements like calcium, chloride, sodium, or iron. These trace elements in small amounts can be beneficial as these elements are sometimes deficient in an aquaponic system. Municipal water often contains chlorine which is toxic to both your fish and your plants. If you know your water source has chlorine, you must arrange to have it removed before placing fish and/or plants in it. There are several ways to accomplish the removal of chlorine including: purchasing a water purification system for your entire home so not only your fish and plants are chlorine free but your family is also. You can also purchase a unit that attaches to the hose you use to fill your system. Chlorine can also be removed with lots of aeration. You let your system run for a couple of days with only water in it to allow the chlorine to dissipate. You need to use a chlorine test kit to signal when your water is safe for your fish, plants, and bacteria. A safe level is less than 1 mg/l of chlorine. Another toxic element in municipal water is chloramine which can be removed using a chemical water conditioner.

There was a time when rainwater was an excellent source of water for an aquaponic farmer; but it's no longer reliable and can often contain contaminants especially in large cities where "acid rain" is a known occurrence. We also do not recommend reverse osmosis water unless you're supplementing it with minerals due to the fact that it is lacking in anything that may be beneficial to your plants or fish. If your water

is highly alkaline, then an RO unit may be required. We have found it necessary to install one of these ourselves due to the high alkalinity of our well water. Once your system is filled with good source water, you need to circulate your system for a day or two to bleed off any gases that it may contain. This also allows you to monitor and test your system to make sure it is working properly before adding the fish and the plants.

What's it take to be a backyard Aquaponic Farmer? Or do you want to be a Commercial Farmer? Go to our Commercial site at [Aquaponics Earth](#).

Several years back, the Air Force ran some tests to determine which airmen would make the best paratroopers. After putting their target subjects through an entire battery of trials, exams and exercises what was determined was as simple as this: The best paratroopers were the airmen who really wanted to be paratroopers. Needless to say, to be an Aquaponic Farmer you have to want to be an Aquaponic Farmer. You don't have to be a water scientist, an engineer, an advanced horticulturist. But you do need to be responsible for *taking measurements* and adding what's required when those measurements indicate it.