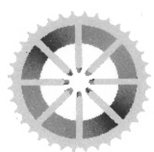
XTREME BIOFILTERS®

Manufactured by ***SeaGateFilters, Inc.***
6219 Gum Street Alexandria, VA 22310
703-627-7504

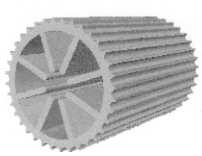
THINGS YOU SHOULD KNOW

Your Xtreme Bio Filter is a bio and mechanical filter, high performance, totally corrosion-proof filter that provides superior flow characteristics and features with ease of operation. It represents the latest innovation in pond filtration technology. It is virtually foolproof in design and operation and when installed, operate and maintained according to instructions, your Xtreme Bio Filter will produce clear water with only minimal attention and care.

How It Works



Xtreme Bio-Media X250



Mechanical Filtration: The Xtreme Bio Filter uses a unique, patented designed Xtreme Bio Media. The media are packed inside the filter volume remove dirt particles from pond as it enters the filter at the top of the media packing. The dirty water containing dirt particles is pumped from the pond through your piping system and directed by the multiport valve to the top of the filter tank. As the dirty water travels through the media packing, dirt particles are trapped in void spaces between the media and within the media cavities. Filtered water exits at the bottom of the filter via the diffuser head, located at the bottom of the filter, through the multiport valve and back to the pond through the piping system. This entire sequence is continuous and automatic and provides total re-circulation of pond water through the Xtreme Bio Filter and the piping system.

After a period of time, the accumulated dirt in the filter causes a resistance to flow, and the flow diminishes. This means it is time to clean (backwash) your filter. With the multiport valve in backwash position, the water flow is automatically reversed through the filter so that it is directed to the bottom of the tank, exits out at the angled slots on the diffuser head, up through the media packing, to the top through the multiport valve and out to the waste line. As the water exits through the angled slots on the diffuser head, it forms jets with cyclonic action, unpack the media packing. Since the Xtreme Bio Media, is a patented designed media for this purpose, it is made of neutral buoyant material, thus the media required a very gentle force to be agitated and move around inside the filter at the same time send dirt and debris to the top of the filter, through the multiport valve and out to the waste line. Once the filter is backwashed (cleaned) of dirt, the multiport valve is manually re-sequenced to Rinse, and then Filter, to resume normal filtering.

Biological Filtration: Each cubic foot of Xtreme Bio Media provides approximately 870 square feet of surface area for bacteria colonization. Bacteria live on these surfaces are essential for converting harmful Ammonia, and Ammonium Nitrite, which are produced by fish waste and decomposition of organic matters in the pond such as uneaten fish food, dead plants, or dead algae, leaves, etc...to safe Ammonium Nitrate. The conversion process is called Nitrification.

Nitrification Cycle:

Like all living creatures, fish give off waste products (pee and poo). These nitrogenous waste products break down into ammonia (NH_3), which is highly toxic to most fishes. In nature, the volume of water per fish is extremely high, and waste products become diluted to low concentrations. In aquariums, however, it can take as little as a few hours for ammonia concentrations to reach toxic levels.

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How much ammonia is too much?

The quick answer is: if a test kit is able to measure it, you've got too much (e.g., it's in enough concentrations to stress fish). Consider emergency action to reduce the danger

The "nitrogen cycle" is the biological process that converts ammonia into other, relatively harmless nitrogen compounds. Fortunately, several species of bacteria do this conversion for us. In particular, Nitrosomonas species (among others) convert ammonia (NH3) to nitrite (N02-), while Nitrobacter species (among others) convert nitrite to nitrate (NO3-). Thus, cycling the tank refers to the process of establishing bacterial colonies in the filter bed that convert ammonia->nitrite->nitrates.

The desired species of nitrifying bacteria are present everywhere (e.g., in the air). Therefore, once you have an ammonia source in your tank, it's only a matter of time before the desired bacteria establish a colony in your filter bed. The most common way to do this is to place one or two (emphasis on one or two) hardy and inexpensive fish in your aquarium. The fish waste contains the ammonia on which the bacteria live. Don't overfeed them! More food means more ammonia! Some suggested species include: common goldfish (for cold water tanks), zebra danios and barbs for warmer tanks, and damselfishes in marine systems. Note: Do not use "toughies" or other feeder fishes. Although cheap, they are extremely unhealthy and using them may introduce unwanted diseases to your tank.

During the cycling process, ammonia levels will go up and then suddenly plummet as the nitrite-forming bacteria take hold. Because nitrate-forming bacteria don't even begin to appear until nitrite is present in significant quantities, nitrite levels skyrocket (as the built-up ammonia is converted), continuing to rise as the continually-produced ammonia is converted to nitrite. Once the nitrate-forming bacteria take hold, nitrite levels fall, nitrate levels rise, and the tank is fully cycled.

Your tank is fully cycled once nitrates are being produced (and ammonia and nitrite levels are zero). To determine when the cycle has completed, buy appropriate test kits and measure the levels yourself, or bring water samples to your fish store and let them perform the test for you (perhaps for a small fee). This process normally takes anywhere from 2-8 weeks. At temperatures below 70F, it takes even longer to cycle a tank. In comparison to other types of bacteria, Nitrifying bacteria grow slowly. Under optimal conditions, it takes fully 15 hours for a colony to double in size!

It is sometimes possible to speed up the cycling time.

Warning:

AVOID THE TEMPTATION TO GET MORE FISH UNTIL AFTER YOUR TANK HAS FULLY CYCLED! More fish means more ammonia production, increasing the stress on all fish and the likelihood of fish deaths. Once ammonia levels reach highly stressful or toxic levels, your tank has succumbed to "New Tank Syndrome"; the tank has not yet fully cycled, and the accumulating ammonia has concentrations lethal to your fish.

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How much ammonia is too much?

In an established tank, ammonia should be undetectable using standard test kits available at stores. The presence of detectable levels indicates that your bio filter is not working adequately, either because your tank has not yet cycled, or the filter is not functioning adequately (e.g., too small for fish load, clogged, etc.) It is imperative that you address the problem (filter) in addition to the symptoms (high ammonia levels).

The exact concentration at which ammonia becomes toxic to fish varies among species; some are more tolerant than others. In addition, other factors like water temperature and chemistry play a significant role. For example, ammonia (NH3) continually changes to ammonium (Nh4+) and vice versa, with the relative concentrations of each depending on the water's temperature and pH. Ammonia is extremely toxic; ammonium is relatively harmless. At higher temperatures and pH, more of the nitrogen is in the toxic ammonia form than at lower pH.

Standard test kits measure total ammonia (ammonia plus ammonium) without distinguishing between the two forms. The following chart gives the maximum long-term level of nitrate-N in mg/L that can be considered safe at a given temperature and pH. Again, note that a tank with an established biological filter will have no detectable ammonia; this chart is provided only for emergency purposes. If your levels approach or exceed the levels shown, take emergency action IMMEDIATELY.

	Water Temperature	
pH	20C (68F)	25C (77F)
6.5	15.4	11.1
7.0	5.0	3.6
7.5	1.6	1.2
8.0	0.5	0.4
8.5	0.2	0.1

What can be done to minimize stress (and potential fish deaths) during the tank cycling phase?

Should ammonia levels become high during the cycling process, corrective measures will need to be taken to prevent fish deaths. Most likely, you will simply perform a sequence of partial water changes, thereby diluting ammonia to safer concentrations.

As a final caution, several commercial products (e.g., "Amquel" or "Ammo-Lock") safely neutralize ammonia's toxicity. Amquel does not remove the ammonia, it simply neutralizes its toxicity. Biological filtration is still needed to convert the (neutralized) ammonia to nitrite and nitrate. Thus, adding Amquel causes the ammonia produced by the fish to be neutralized instantly, yet still allows the nitrification cycle to proceed. Using Amquel during the cycling phase has one significant drawback, however. Amquel (and similar products) may cause ammonia test kits to give false readings, making it difficult to determine exactly when cycling has completed.

It is also possible to cycle a tank without ever adding fish. The role fish provide in the cycling process is simply their steady production of ammonia; the same effect can be achieved by adding chemical forms of ammonia manually (e.g., ammonium chloride). However, it is a bit more complicated than using fish because the water chemistry needs to be monitored more closely in order to add the proper amount of ammonia on a day-to-day basis.

I'm impatient. How can I speed up the cycling time?

The nitrogen cycle can be speeded up or "jump started" in a number of ways. Unfortunately, they require access to an established tank, which a beginning aquarist may not have available. The basic idea is to find an established tank, take some of the bacteria out of it and place it in the new tank.

Most filters have some sort of foam block or floss insert on which nitrifying bacteria attach. Borrowing all or part of such an insert and placing it in the new tank's filter gets things going more quickly.

If the established tank uses an undergravel filter, nitrifying bacteria will be attached to the gravel. Take some of the gravel (a cup or more) and hang it in mesh bag in your filter (if you can), or lay it over the top of the gravel in the new tank (if it has an UGF).

If you have a box, sponge or corner filter, simply connect it to an established aquarium and let it run for a week or so. Bacteria in the water will establish a bed in the new filter. After a week, move the now "seasoned" filter to the new tank.

More recently, products containing colonies of nitrifying bacteria have become available at pet shops (e.g., "Fritz", "Bio-zyme", "Cycle"). In theory, adding the bacteria jump-starts the colonization process as above. Net experience with such products has been mixed; some folks report success, while other report they don't work at all. In principle, such products should work well. However, nitrifying bacteria cannot live indefinitely without oxygen and food. Thus, the effectiveness of a product depends on its freshness and can be adversely effected by poor handling (e.g., overheating). Unfortunately, these products don't come with a freshness date, so there is no way to know how old they are.

Some (not many) aquarium stores will provide aquarium buyers with a cup of gravel from an established tank. A word of caution is appropriate here. Due to the nature of the business, tanks in stores are very likely to contain unwanted pathogens (bacteria, parasites, etc.); you don't want to add them to an established tank. For someone setting up their very first tank, however, all fish will probably be purchased from the same store, so the danger is relatively small, as the newly purchased fish will have been exposed to the same pathogens. If possible, seed a filter with bacteria from a non-store tank.

Of course, there are many variations on the above that work. However, it is a bit difficult to give an exact recipe that is guaranteed to work. It is advisable to take a conservative approach and not add fish too quickly. In addition, testing the water to be sure nitrates are being produced eliminates the guesswork of determining when your tank has cycled.

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What is meant by "stressing" fish, and why is stress a bad thing?

Most fish can tolerate environmental conditions that differ somewhat from the natural conditions in which they evolved. This does not mean, however, that they will be as healthy or live their full normal life span. For example, keeping a fish in water that is cooler (or warmer) than its preferred condition forces its body organs to work harder to keep it alive. That is, such conditions place the fish under increased stress.

Increased stress reduces a fish's ability to ward off diseases and heal itself (e.g., if its fins get nicked, or parasites get introduced into the tank with newly purchased fish). In addition, stress reduces a fish's ability to breed successfully and shortens its natural life span. A small amount of stress by itself is not usually fatal, but as stress levels increase, a fish's ability to cope with it decreases. Thus, one of the most important goals of a fishkeeper is to remove sources of stress wherever possible.

It should be noted that eliminating stress does not guarantee that your tank will be healthy. But it significantly increases the odds. Many netters boast regularly about how they've kept fish (apparently) "healthy & happy" for long periods of time under (apparently) highly stressful conditions. Such aquarists are sitting on a time-bomb; the not uncommon followup story will refer to one fish getting sick, then another, with an end result of multiple fish deaths. Reducing stress simply increases the likelihood that a tank will stay healthy (much the same way as eating right, exercising, getting the proper amount sleep is generally associated with a long healthy life for humans).

What are the common factors that lead to stress in aquariums?

In the following, we list some of the more common stress-inducing conditions. In all cases, the level of stress induced by a specific factor is highly species-dependent. Thus, an aquarist is advised to be aware of the type of stress that will be present in their tanks and select fish known to tolerate such conditions well. For example, if your water is hard and alkaline, you're best off selecting fish that thrive under such conditions.

Nitrogen compounds (ammonia, nitrite and nitrate) have varying degrees of toxicity and are stressful at all levels. Ammonia is toxic in low concentrations. In ANY concentrations, ammonia severely stresses fish. Consequently, a healthy aquarium must have an adequate biological filter that quickly converts ammonia to nitrite (and nitrate). Although significantly less toxic than ammonia or nitrite, nitrate also stresses fish. Thus, a means of removing excess nitrate (e.g., through regular water changes) helps keep an aquarium healthy.

The water temperature of your tank should match the needs of its inhabitants. Keeping water temperature too cold or too warm for a particular species will stress those fish. For example, goldfish prefer cooler temperatures (less than 70F) than most tropical fish (goldfish survive winters in ponds where temperatures approach freezing), guaranteeing that a tank containing both goldfish and tropicals will either be too cold or too warm for some of the inhabitants.

Some fish prefer soft water, others prefer hard water. Keeping a soft-water preferring fish in

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Some fish prefer acidic water, some prefer alkaline water, others prefer water with a neutral pH. (Some fish don't care too much.)

Some fish live in brackish water conditions; they will do better in water with a small amount of added salt. Other species are extremely intolerant of salt. Add salt only if all of a tank's inhabitants can tolerate salinity. Mollies, for example are known to like salt, whereas many species of catfish tolerate no salt at all. In general, fish lacking scales (or having small scales) don't tolerate salt well.

The amount of physical space required for a particular fish depends on its species. Some fish do just fine in a 10g tank, others need 100g or more. Keeping a fish in a tank that is too small for it increases the level of stress (on everyone), frequently leading to increased aggression among tank inhabitants. Note also that the amount of space required may change should fish pair off to breed. Breeding cichlids, for example, claim a portion of the tank for themselves, chasing away any fish that encroach on its territory. Thus, the onset of breeding behaviors frequently increases stress levels.

Not all species of fish mix well with others. As an obvious example, most cichlids will eat smaller tank inhabitants (e.g., anything they can fit in their mouths). Even if too big to be eaten, however, peaceful fish will be stressed if kept with aggressive fish that chase them around all day. Moreover, many fish communicate through behavior and body language (e.g., cichlids frequently establish a "pecking order" in which one fish is king). Fish of one type of species may not recognize the signals given off by others, guaranteeing continual strife.

Some fish school in nature, spending their entire lives in large groups (rather than individually); they never feel comfortable or "safe" when kept by themselves. Cory cats for example, do better in a tank with 6 or more other Corys than they do by themselves. While it may be tempting to buy six different kinds of fish, this may not be ideal for the fish themselves. The opposite can also be true. Some fish are more aggressive towards members of their own species (e.g., mating behaviors), whereas they may not feel threatened by other species and pretty much ignore them.

Fish need oxygen, and some fish are more tolerant of low-oxygen water than others. Water with insufficient oxygen stresses fish. Note that as the water temperature goes up, the amount of dissolved oxygen in water decreases.

Poor nutrition also causes stress. A healthy diet is a varied diet, and one should avoid using old foods in which vitamins and other nutrients have broken down. "Old food" includes food that has been stored in hot places, been exposed to air (not sealed), etc.

The "cure" of adding medicines to tanks is often worse than the original disease. Medications that kill bacteria, parasites, etc. are usually not too discerning: they may also kill your nitrifying bacteria (now you REALLY have a major problem) or be toxic to the fish themselves. For example, some species of fish do not tolerate certain types of medicines at all. Adding such medications may weaken healthy fish to the point that they become susceptible to the original disease.

Adding untreated water to your tank may introduce chlorine or chloramine, both of which are toxic to fish. Be sure to treat all water prior to adding it to your tank.

Sudden change in water conditions can be stressful. Within limits, most fish can adjust to sub-optimal water conditions (e.g., wrong temperature, wrong pH). However, fish have difficulty adjusting to a SUDDEN change in water chemistry. Thus suddenly raising (or lowering) the temperature, changing the pH, changing the water hardness, etc. stresses a fish. It is more important to keep the water chemistry stable over the long haul than keeping water conditions exactly optimal.

In summary, many factors lead to fish stress. Minimizing and eliminating sources of stress increases the chances of keeping tank inhabitants healthy. The exact amount of a stress individual fish can take depends greatly on what species it is, its age and size, etc. A stressed fish is a weakened fish. Although it may appear healthy to the casual observer, it will be more susceptible to disease, injury, etc. In contrast, healthy (unstressed) fish will be able to ward off disease and infection on their own. Thus, the appearance of disease in a tank is frequently brought on by "poor water conditions" that leave fish with weakened immune systems.
How can I tell if my fished are stressed?
In short, stressed fish don't "act normal", with "normal" defined according to the species of fish. Once you've had fish for a few weeks, you'll see that each species behaves in its own characteristic way (that's why fish are fun to have!). Some fish tend to always stay near the top of the water, others near the bottom. Some fish swim continuously, others stay in one place. Deviation from that norm usually indicates stress.

Common symptoms of stress include:

Fish stays near the surface gasping for breath, indicating that it has trouble getting enough oxygen (the concentration of dissolved oxygen is highest near the water's surface). Possible causes include low oxygen concentration due to poor water circulation, toxins that have damaged its gills, high ammonia or nitrite levels, etc.

Fish won't eat, or doesn't eat as aggressively as in past.

Fish stays hidden continuously and won't come out where it can be seen. Possible causes: aggressive fish, insufficient cover (e.g., plants, wood, etc.) to make fish feel "safe" while swimming about.

Fish has nicked fins, open wounds that don't seem to heal. Possible cause: fish is target of aggression. Normally, minor nicks and cuts heal quickly. If they don't, stress levels may be suppressing the fish's immune system.

Fish has disease (parasites, fungus, etc.) Of course, the disease itself is a major problem. But in most cases, a healthy fish's immune system keeps it from getting sick in the first place. Thus, getting sick is a sign that the fish is in a stressed state (or had been until recently).

What do you need to know about water chemistry and why?

Water in nature is rarely pure in the "distilled water" sense; it contains dissolved salts, buffers, nutrients, etc., with exact concentrations dependent on local conditions. Fish (and plants) have evolved over millions of years to the specific water conditions in their native habitats and may be unable to survive in significantly different environments.

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Beginners (and especially the lazy) should take the easy approach of selecting fish whose needs match the qualities of their normal tap water. Alternatively, an advanced (and energetic!) aquarist can change the water characteristics to match the fish's needs, though doing so is almost always more difficult than first appears. In either case, you need to know enough about water chemistry to ensure that the water in your tank has the right properties for the fish you are keeping.

Water has four measurable properties that are commonly used to characterize its chemistry. They are:

pH refers to water being either an acid, base, or neither (neutral). A pH of 7 is said to be neutral, pH's below 7 are "acidic" and pH's above 7 are "basic" or "alkaline". Like the Richter scale used to measure earthquakes, the pH scale is logarithmic. A pH of 5.5 is 10 times more acidic than water at a pH of 6.5. Thus, changing the pH by a small amount (suddenly) is more of a chemical change (and more stressful to fish!) than might first appear.

To a fishkeeper, two aspects of pH are important. First, rapid changes in pH are stressful to fish and should be avoided. Changing the pH by more than .3 units per day is known to stress fish. Thus, you want the pH of your tank to remain constant and stable over the long haul. Second, fish have adapted to thrive in a (sometimes narrow) pH range. You want to be sure that your tank's pH matches the specific requirements of the fish you are keeping.

Most fish can adjust to pHs somewhat outside of their optimal ranges. If your water's pH is naturally within the range of 6.5 to 7.5, you will be able to keep most species of fish without any problems. If your pH lies within this range, there is probably no need to adjust it upward or downward.

Buffering capacity refers to water's ability to keep the pH stable as acids or bases are added. pH and buffering capacity are intertwined with one another; although one might think that adding equal volumes of an acid and neutral water would result in a pH halfway in between, this rarely happens in practice. If the water has sufficient buffering capacity, the buffering capacity can absorb and neutralize the added acid without significantly changing the pH. Conceptually, a buffer acts somewhat like a large sponge. As more acid is added, the "sponge" absorbs the acid without changing the pH much. The "sponge's" capacity is limited however; once the buffering capacity is used up, pH changes more rapidly as acids are added.

Buffering has both positive and negative consequences. On the plus side, the nitrification cycle produces nitric acid (nitrate). Without buffering, your tank's pH would drop over time (a bad thing). With sufficient buffering, the pH stays stable (a good thing). On the negative side, hard tap water often almost always has a large buffering capacity. If the pH of the water is too high for your fish, the buffering capacity makes it difficult to lower the pH to a more appropriate value. Naive attempts to change the pH of water usually fail because buffering effects are ignored.

In freshwater aquariums, most of water's buffering capacity is due to carbonates and bicarbonates. Thus, the terms "carbonate hardness" (KH), "alkalinity" and "buffering capacity" are used interchangeably. Although technically not the same things, they are equivalent in practice in the context of fish keeping. Note: the term "alkalinity" should not be confused with the term "alkaline". Alkalinity refers to buffering, while alkaline refers to a solution that is a base (e.g., pH > 7).

How much buffering does your tank need? Most aquarium buffering capacity test kits actually measure KH. The larger the KH, the more resistant to pH changes your water will be. A tank's KH should be high enough to prevent large pH swings in your tank over time. If your KH is below roughly 4.5 dH, you should pay special attention to your tank's pH (e.g, test weekly, until you get a feel for how stable the pH is). This is ESPECIALLY important if you neglect to do frequent partial water changes. In particular, the nitrification cycle creates a tendency for an established tank's pH to decrease over time. The exact amount of pH change depends on the quantity and rate of nitrates produced, as well as the KH. If your pH drops more than roughly a two tenths of a point over a month, you should consider increasing the KH or performing partial water changes more frequently. KH doesn't affect fish directly, so there is no need to match fish species to a particular KH.

Note: it is not a good idea to use distilled water in your tank. By definition, distilled water has essentially no KH. That means that adding even a little bit of acid will change the pH significantly (stressing fish). Because of its instability, distilled (or any essentially pure water) is never used directly. Tap water or other salts must first be added to it in order to increase its GH and KH.

General hardness (GH) refers to the dissolved concentration of magnesium and calcium ions. When fish are said to prefer "soft" or "hard" water, it is GH (not KH) that is being referred to.

Note: GH, KH and pH form the Bermuda's Triangle of water chemistry. Although the three properties are distinct, they all interact with each other to varying degrees, making it difficult to adjust one without impacting the other. That is one reason why beginning aquarists are advised NOT to tamper with these parameters unless absolutely necessary. As an example, "hard" water frequently often comes from limestone aquifers. Limestone contains calcium carbonate, which when dissolved in water increases both the GH (from calcium) and KH (from carbonate) components. Increasing the KH component also usually increases pH as well. Conceptually, the KH acts as a "sponge" absorbing the acid present in the water, raising the water's pH.

Water hardness follows the following guidelines. The unit dH means "degree hardness", while ppm means "parts per million", which is roughly equivalent to mg/L in water. 1 unit dH equals 17.8 ppm $CaCO_3$. Most test kits give the hardness in units of $CaCO_3$; this means the hardness is equivalent to that much $CaCO_3$ in water but does not mean it actually came from $CaCO_3$.

0 - 4 dH, 0 - 70 ppm : very soft
4 - 8 dH, 70 - 140 ppm : soft
8 - 12 dH, 140 - 210 ppm : medium hard
12 - 18 dH, 210 - 320 ppm : fairly hard
18 - 30 dH, 320 - 530 ppm : hard
higher : liquid rock (Lake Malawi and Los Angeles, CA)

Salinity refers to the total amount of dissolved substances. Salinity measurements count both GH and KH components as well as such other substances as sodium. Knowing water's salinity becomes important in salt water aquariums. In freshwater tanks, knowing pH, GH and KH suffices.

Salinity is usually expressed in terms of its specific gravity, the ratio of a solution's weight to weight of an equal volume of distilled water. Because water expands when heated (changing its density), a common reference temperature of 39F degrees is used. Salinity is measured with a hydrometer, which is calibrated for use at a specific temperature (e.g., 75F degrees is common).

One component of salinity that neither GH or KH includes is sodium. Some freshwater fish tolerate (or even prefer) a small amount of salt (it stimulates slime coat growth). Moreover, parasites (e.g., ick) do not tolerate salt at all. Thus, salt in concentrations of (up to) 1 tablespoon per 5 gallons can actually help prevent and cure ick and other parasitic infections.

On the other hand, some species of fish do not tolerate ANY salt well. Scaleless fish (in general) and some Corydoras catfish are far more sensitive to salt than most freshwater fish. Add salt only if you are certain that all of your tank's inhabitants prefer it or can at least tolerate it.

What else do I need to know about water chemistry?

In addition to GH, KH, pH and salinity, there are a few other substances you may want to know about. Most tap water contains an assortment of trace elements in very low concentrations. The presence (or absence) of trace elements can be important in some situations. Specifically:

Phosphates have been linked to algae growth. If you have persistent algae problems, high phosphates may be a contributing factor. In a plant tank, ideal phosphate levels are .2 mg/L or lower. To control algae, frequent partial water changes are often recommended to reduce nutrient levels. If your tap water contains excess phosphate, water changes may be aggravating the situation. Your local water company can tell you what the exact phosphate levels are.

Plants need iron in trace quantities to grow. Tap water in many areas contains no iron at all. Consult the Plant FAQ for more details.

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How can I raise my GH and/or KH ?

The following measurements are approximate; use a test kit to verify you've achieved the intended results.

To raise both GH and KH simultaneously, add calcium carbonate ($CaCO_3$). Two teaspoons per 50 Liters of water will increase both the KH and GH by about 4 dH. Alternatively, add some sea shells, coral, limestone, marble chips, etc. to your filter.

To raise the KH without raising the GH, add sodium bicarbonate ($NaHCO_3$), commonly known as baking soda. One teaspoon per 50 Liters raises the KH by about 4 dH. Sodium bicarbonate drives the pH towards an equilibrium value of 8.2.
How do I raise or lower pH?

One can raise or lower pH by adding chemicals. Because of buffering, however, the process is difficult to get right. Increasing or decreasing the pH (in a stable way) actually involves changing the KH. The most common approach is to add a buffer whose equilibrium holds the pH at the desired value.

Muriatic (hydrochloric) acid can be used to reduce pH. Note that the exact quantity needed depends on the water's buffering capacity. In effect, you add enough acid to use up all the buffering capacity. Once this has been done, decreasing the pH is easy. However, it should be noted that the resultant lower-pH water has much less KH buffering than it did before, making it more susceptible to pH swings when (say) nitrate levels rise. Warning: It goes without saying that acids are VERY dangerous! Do not use this approach unless you know what you are doing!

Products such as "pH-Down" are based on the acid phosphoric acid. Phosphoric acid tends to keep the pH at roughly (6.5 ???). Unfortunately, use of phosphoric acid has the BIG side effect of raising the phosphate level in your tank, stimulating algae growth. It is difficult to control algae growth in a tank with elevated phosphate levels.

One safe way to lower pH WITHOUT adjusting KH is to bubble CO_2 (carbon dioxide) through the tank. The CO_2 dissolves in water, and some of it forms carbonic acid. The formation of acid lowers the pH. Of course, in order for this approach to be practical, a steady source of CO_2 bubbles (e.g.. a CO_2 tank) is needed to hold the pH in place. As soon as the CO_2 is gone, the pH bounces back to its previous value. The high cost of a CO_2 injection system precludes its use as a pH lowering technique in most aquariums. However CO_2 injection systems are highly popular in heavily tanks, because the additional CO_2 stimulates plant growth.
How do I soften water (e.g., lower its GH)?

Some fish (e.g., discus, cardinal tetras, etc.) prefer soft water. Although they can survive in harder water, they are unlikely to breed. Thus, you may feel compelled to soften your water despite the hassle involved in doing so.

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Typical home water softeners soften water using a technique known as "ion exchange". That is, they remove calcium and magnesium ions by replacing them with sodium ions. Although this does technically make water softer, most fish won't notice the difference. That is, fish that prefer soft water don't like sodium either, and for them such water softeners don't help at all. Thus, home water softeners are not an appropriate way to soften water for aquarium use.

Fish stores also market "water softening pillows". They use the same ion-exchange principle. One "recharges" the pillow by soaking it in a salt water solution, then places it in the tank where the sodium ions are released into the water and replaced by calcium and magnesium ions. After a few hours or days, the pillow (along with the calcium and magnesium) are removed, and the pillow recharged. The pillows sold in stores are too small to work well in practice, and shouldn't be used for the same reason cited above.

Peat moss softens water and reduces its hardness (GH). The most effective way to soften water via peat is to aerate water for 1-2 weeks in a bucket containing peat moss. For example, get a (plastic) bucket of the appropriate size. Then, get a large quantity of peat (gallon or more), boil it (so that it sinks), stuff it in a pillow case, and place it in the water bucket. Use an air pump to aerate it. In 1-2 weeks, the water will be softer and more acidic. Use this aged water when making partial water changes on your tank.

Peat can be bought at pet shops, but it is expensive. It is much more cost effective to buy it in bulk at a local gardening shop. Read labels carefully! You don't want to use peat containing fertilizers or other additives.

Although some folks place peat in the filters of their tanks, the technique has a number of drawbacks. First, peat clogs easily, so adding peat isn't always effective. Second, peat can be messy and may cloud the water in your tank. Third, the exact quantity of peat needed to effectively soften your water is difficult to estimate. Using the wrong amount results in the wrong water chemistry. Finally, when doing water changes, your tank's chemistry changes when new water is added (it has the wrong properties). Over the next few days, the chemistry changes as the peat takes effect. Using aged water helps ensure that the chemistry of your tank doesn't fluctuate while doing water changes.

Hard water can also be softened by diluting it with distilled water or R/O water. R/O (reverse-osmosis) water is purified water made by a R/O unit. Unfortunately, R/O units are too expensive ($100-$500) for most hobbyists. R/O water can also be purchased at some fish stores, but for most folks the expense and hassle are not worth it. The same applies to distilled water purchased at grocery stores.

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I use municipal tap water in my aquarium. What do I need to know?

Most people use tap water in their tanks; it is easiest (and cheapest) to use. Unfortunately (for aquarists), local water companies add chemicals to the water to make it safe to drink (e.g., by adding chlorine or chloramine to kill bacteria). More recently, concern about water flowing through (older) lead pipes has caused some water utilities to add pH-raising chemicals to the water (lead dissolves less readily in alkaline water). Consequently, tap water must be specially treated before it can safely be used in fish tanks.

Another potential problem to be aware of concerns variability in the chemical properties of your water supply over time (e.g., month-to-month). Some water districts don't have enough water themselves, forcing them to purchase additional water from neighboring water districts in times of shortages. If this water has a different hardness (for example), your tap water's hardness will vary as well. As a common example, high bacteria levels are more of a problem in summer than winter, especially in warmer climates. Consequently, it is not uncommon for water companies to use more chlorine in summer months to keep bacteria in check. Even such factors as local weather can have an impact; heavy rains may cause the hardness of your water supply to decrease, as local reservoirs fill.

In general, chlorine and chloramine are the two additives that cause the most problems. Note that these two substances are VERY DIFFERENT! Be sure you know what is in your tap water and treat appropriately.

What do I need to know about chlorine?

In the US, EPA guidelines require that tap water at any faucet contain a minimal chlorine concentration of .2 ppm, and stringently limits the concentration of bacteria (which may require more than .2 ppm chlorine to keep in check). Because chlorine breaks down over time, the chlorine concentration of the water that comes out of your tap will be lower than that put in at water plant. Thus, the exact concentration at your faucet depends on how far you are from the water plant, how long it takes the water to travel from the water plant to your house, how much chlorine is initially added, etc.

Chlorine at high concentrations is toxic to fish; at lower concentrations, it stresses fish by damaging their gills. Concentrations of as little as .2-.3 ppm kill most fish fairly rapidly. To prevent stress, concentrations as low as 0.003 ppm may be required. Fortunately, chlorine can easily be removed from water by the chemical sodium thiosulfate, readily available at fish stores under various brands. Sodium thiosulfate neutralizes chlorine instantly. Note that there are many "water treatment" products that are advertised as "making tap water safe". Read labels carefully. Inevitably, the ones that neutralize chlorine all contain sodium thiosulfate, plus other substances that may or may not be useful. If your water only contains chlorine (as opposed to chloramine), sodium thiosulfate is all you need. The most cost-effective treatments use only 1 drop per gallon of water. Most other water treatments are much more expensive in the long-term; they may require a teaspoon of treatment (or more) per gallon!

Chlorine is relatively unstable in water, escaping to the atmosphere on its own. Water left in a bucket (or tank) with adequate water circulation (e.g. filter or airstone) will be free of chlorine in 24 hours or less.

Many netters report that they perform partial water changes without ever treating their tap water to remove chlorine. Keep in mind that even though fish show no APPARENT ill-effect from untreated water, that doesn't mean that the chlorine isn't stressing your fish. How much stress depends on how much chlorine is introduced to the tank, which depends on many factors (including the percentage of new water added). Because chlorine removers are so cheap (pennies per usage), the insurance they provide should not be passed up.

What do I need to know about chloramine?

One problem with using chlorine to treat water is that it breaks down relatively quickly. Another concern with the use of chlorine is that it can combine with certain organics (that may or may not be present in your water) forming trihalomethanes, a family of carcinogens. Consequently, many water companies have switched from using chlorine to using chloramine. Chloramine, a compound containing both chlorine and ammonia, is much more stable than chlorine.

Chloramine poses two significant headaches for aquarists. First, chlorine-neutralizing chemicals such as sodium thiosulfate only neutralize the chlorine portion of chloramine, neglecting an even bigger problem: deadly ammonia. The consequences can be devastating to fish. Although a tank's biological filter will (eventually) convert the ammonia to nitrate, the time it takes to do so may be longer than what your fish can tolerate.

The second problem relates to water changes. One of the primary reasons for doing regular water changes is to remove nitrates that build up. If your replacement tap water contains ammonia, you'll be putting nitrogen right back into your tank and it will be impossible to reduce the nitrates below the concentration in your tap water. Fortunately, tap water concentrations are relatively low (1 or 2 ppm); you are more likely to have a much higher concentration of nitrate in your tank.

Chloramine can be safely neutralized through such products as Amquel, which neutralize both the ammonia and chlorine portions of the chloramine molecules. The neutralized ammonia will still be converted to nitrates via a biological filter.

Another method for neutralizing chloramine is to age it while simultaneously performing biological filtration. For example, get an appropriately-sized (plastic) garbage can, fill it with tap water, dechlorinate it with sodium thiosulfate, and then connect an established biological filter to it. Just as in your tank, the bio filter will convert the ammonia to nitrate, after which it can safely be added to your tank. Note: you must add sodium thiosulfate to neutralize the chlorine; otherwise, the chloramine will kill the bacteria in your biological filter.

Alternatively, the ammonia can removed by filtering the water through zeolite or carbon before adding it to your tank. [Note: folks report mixed success with this. If you have concrete (positive or negative) experience to report, please notify the FAQ maintainers.
Are there any other water impurities that I should be aware of?
Quite possibly. In addition to the additives described above (chlorine & chloramine), municipal water may (or may not!) contain other elements that the aquarist may need to know about. Water in some locations actually contains nitrates. In some places, water contains elevated concentrations of phosphates (1 ppm or more). High phosphate has been linked to algae problems, and a comprehensive algae control strategy may require removing phosphates. High levels of iron (1 ppm or more) have also been linked to thread algae. Consult the algae section of this FAQ for more details.

How do I find out just what my local water company is adding to the water?

The quick answer is to ask someone who knows. A local fish store (if they reside in the same water district as you do) should be able to tell you. Alternatively, call your local water utility. Ask to speak with the "water chemist". Tell them you are an aquarist and want to know about the pH, GH, and KH of your water, as well as how much the water characteristics vary from month to month. Finally, (in the US) if you really want details, have them send you a copy of the periodic water report they are required to generate for the EPA. It contains a detailed listing of exactly what your water contains and in what concentrations (e.g., iron, nitrates, phosphates, etc.). By law, the report is available for public inspection.
I don't have city water. Can I use my well water?
Yes. One advantage with well water is that you don't need to deal with chlorine and chloramine. On the other hand, well water is frequently (much!) harder than water available through local utilities. In addition, the only way to know its composition (GH, KH, etc.) is to run tests on it yourself. Alternatively, there are companies to which you can send water samples that will perform a detailed analysis of its contents (for $20-100).

One potential problem with using well water is that it frequently contains high concentrations of dissolved gases (e.g., dangerous to fish). For example, well water is frequently supersaturated with CO2, which lowers the water's pH. Once the CO2 escapes, the pH will increase. Fish shouldn't be subjected to this temporary pH fluctuation. For safety, aerate well water thoroughly for several hours before adding it to your tank.
What test kits should I get, and when are they useful?

There is a seemingly endless array of test kits for testing everything from ammonia levels to phosphate levels. Does one really need to buy them? The quick answer is no. It is quite possible to have a healthy tank without ever buying a single test kit. However, test kits are extremely useful at eliminating guesswork when something goes wrong (e.g., fish appear stressed or die). In the following, we describe the test kits that are most useful and the conditions under which they are useful.

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Should I get an ammonia test kit?

Yes. Ammonia test kits are cheap ($5-10) and will tell you whether your tank has elevated ammonia levels. This is useful in two circumstances. First, during the tank-cycling phase, regular testing for ammonia will tell you when the first phase of the nitrogen cycle has completed. Second, should you have unexplained fish deaths, testing for ammonia verifies that your biological filter is (or is not) working correctly. Note that even in an established tank, the biological filter can sometimes weaken or fail outright. Common causes include not cleaning it regularly (water can't flow through a clogged filter, where the nitrifying bacteria reside), naively adding fish medicines (antibiotics kill nitrifying bacteria (oops) as well as disease carrying ones), having too small a filter for the fish load, etc. Be warned: If you have fish deaths and subsequently ask the net (or a fish store) for advice, the first question asked will be "What are your ammonia (and nitrite) levels?".

Ammonia levels are measured in ppm. At concentrations as low as .2-.5 ppm (for some fish), ammonia causes rapid death (also consult cycling section for further details). Even at levels above 0.01-0.02 ppm, fish will be stressed. Common test kits don't register such low concentrations. Thus, test kits should NEVER detect ammonia in an established tank. If your test kit detects ANY ammonia, levels are too high and are stressing fish. Take corrective action immediately. Warning: Amquel and other similar "ammonia-neutralizing" water additives are incompatible with most ammonia test kits. Water treated with Amquel will falsely test positive for ammonia, even when ammonia is not present. Test kits sold under the brand names XXX are known to give false readings under such conditions.

Should I get a nitrite test kit?

Maybe. Nitrite kits are cheap ($5-10) and are useful in the same circumstances where an ammonia test is useful. The only time a nitrite kit provides information that an ammonia kit can't is while testing for completion of the second phase of the nitrogen cycle. As in the case for ammonia, if your test kits detects nitrite, your biological filter is not working adequately. Once a tank has cycled, nitrite kits are pretty much useless. (If the bio filter in an established tank isn't working, both ammonia and nitrite levels will be elevated.)

Nitrite is an order of magnitude less toxic than ammonia. Thus, one common saying about tank cycling is: "if your fish survive the ammonia spike, they'll probably survive the nitrite spike and the rest of the cycling process." However, even at levels above .5 ppm, fish become stressed. At 10-20 ppm, concentrations become lethal.
Should I get a nitrate test kit?

Yes. Nitrate levels increase over time in established tanks as the end result of the nitrogen cycle. (The only exception to this rule is HEAVILY planted tanks, which are SOMETIMES able to consume nitrogen faster than it is produced.) Because nitrates become toxic at high concentrations, they must be removed periodically (e.g., through regular water changes). Having a nitrate test kit helps you determine whether or not your water changes are removing nitrates quickly enough.

Nitrates become toxic to fish (and plants) at levels of 50-300 ppm, depending on the fish species. For fry, however, much lower concentrations become toxic.

Note: A nitrate test kit is only of limited value in determining whether the nitrification cycle has completed. Most nitrate test kits actually convert nitrate to nitrite first, then test for the concentration of nitrite. That is, they actually measure the combined concentration of nitrite and nitrate. In an established tank, nitrite levels are essentially zero, and the kits do properly measure nitrate levels. While a tank is cycling, however, a nitrate kit can't tell you how much of the reading (if any) comes from nitrate rather than nitrite.

Should I have a pH test?

Yes. You will want to know the pH of your tap water so that you can select fish whose requirements meet your water conditions. In addition, you will periodically want check your tank's pH so that you can be sure it stays stable and doesn't increase or decrease significantly over time.

In some cases, tank decorations (e.g., driftwood) or gravel (e.g., of made of coral, shells or limestone) change the pH of your water. For example, tank items may slowly leach ions into your tank's water, raising the GH and KH (and pH). With driftwood, it is not uncommon to have the wood slowly leach tannins that lower the pH.
Should I get a test kit that measures general hardness (GH)?
Maybe. You may want to get one of these, but having one is not critical. You don't need to know the exact hardness level. Knowing whether your water is "soft", "very soft", etc. is good enough. Your local fish store may be able to give you sufficient information. Alternatively, call your water utility.

Should I get a test kit that measures carbonate hardness (KH)?

Maybe. This kit is not critical to have. By regularly monitoring the pH, you can figure out whether your KH is "high enough". That is, the KH should be high enough that your pH stays stable over time. If you have trouble keeping the pH stable, you may want to increase its buffering capacity. Your local fish store may be able to give you sufficient information as to your KH value. Alternatively, call your water utility company.

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What is the purpose of regular water changes, and how frequently should they be done?

The solution to pollution is dilution; water changes replace a portion of "dirty" water with an equal portion of clean water, effectively diluting the concentrations of undesirable substances in your tank. In an established tank, nitrate is the primary toxin that builds up. Regular water changes are the cheapest, safest and most effective way of keeping nitrate levels at reasonable levels. During the tank cycling phase, however, ammonia or nitrite may be the substances that need to be diluted and removed. Likewise, if medications have been added to your tank, they may need to be removed after they've served their primary purpose.

The effectiveness of water changes is determined by two factors: their frequency and the percentage of water that is replaced. The more often water is replaced, or the greater the qantity of replaced water at a change determines overall effectiveness.

The benefits of water changes must be balanced by the stress caused by a sudden change of your tank's water chemistry. If tank water has similar pH, GH and KH as tap water, changing 50% (or more) of the water at one time will not affect fish. On the other hand, if your tank's pH is (for example) 6.3, while your replacement water has a pH of 7.5, replacing 50% of the water all at once will change the pH of your tank significantly (possibly more than 50% depending on buffering factors), which will stress your fish, possibly enough to kill them.

Because water changes are the first line of defense in dealing with problems such as disease, you want to be able to do large, frequent partial water changes during emergency periods. Consequently, you want your tank's water chemistry to closely match that of your replacement water. That way, you always have the option of performing large water changes on short notice. Note that this is the way tanks start out; when you initially set up your tank, the water is the same as that from your tap. Over time, however, the tank's water chemistry may "drift" relative to tap water due to acidification from the nitrification cycle, the addition of chemical additives such as "Ph-up" or "Ph-down", the use non-inert tank gravel (e.g. crushed coral or sea shells), etc.

How frequently should partial water changes be made?

The more frequent the changes, the less water that needs to be replaced. However, the longer between changes, the more stressful changes potentially become, because a larger portion of the water gets replaced. Replacing roughly 25% of your tank's water bi-weekly is a good minimal starting point, but may not be enough. The proper frequency really depends on such factors as the fish load in your tank. Nonetheless, you should do water changes often enough so that:

Nitrate levels stay at or below 50ppm, and preferably MUCH lower (less than 10ppm is a good optimal value). The change in water chemistry resulting from a change is small. In particular, the before and after pH of your tank shouldn't differ by more than .2 units. (Use a test kit the first few times to get a feel for what's right.) If your pH changes too much as a result of a water change, perform changes more frequently, but replace less water at each change.

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Water changes remove nitrates after they've been produced. Nitrogenous substances in the form of uneaten fish food, detritus, etc. can also be removed BEFORE they get broken down into nitrate. This is achieved by cleaning your mechanical and biological filter regularly, and by vacuuming the gravel with a gravel cleaner. This should be done every time you perform a water change, e.g., every two weeks.

Note: if your heater becomes partially exposed to air as the water level drops while doing changes, be sure to unplug your heater while doing your water changes. The heater can crack if the water level drops below the heating coil!

Also, be sure to dechlorinate/dechlorimate the replacement water before adding it to your tank!