



Tank Cycling Problems Solved!

Almost all the problems that new aquarists have with cycling stem from misunderstanding. No other aspect of the aquarium hobby is as surrounded in unnecessary mystery as is tank cycling. People treat it like a secret ritual, whose rites must be followed exactly to the letter. While cycling is somewhat mystifying, it is very important and actually fairly straightforward.



The cause of all the misunderstanding undoubtedly stems from the fact that the many processes involved are all invisible. Except for taking readings from your test kit, you cannot see what is happening nor determine if things are proceeding normally. Since you have no direct way of knowing if the advice you receive is good or not, you must take it on faith.

What Is Cycling Anyway?

Cycling a tank refers to establishing a functioning biofilter. A biofilter is a special bacterial colony growing in some medium through which the aquarium water is directed to pass. These bacteria are of two types. The first consume ammonia, turning it into nitrite. Ammonia is extremely toxic to fish, and nitrite is quite toxic. The second type of bacteria convert nitrite into nitrate. Nitrate is toxic only in large concentrations. Thus, a biofilter takes a very poisonous waste and turns it into a much less harmful substance in a two-step process. The accumulated nitrate is then diluted whenever a water change is performed.

The process is called “cycling” because it sets up part of the nitrogen cycle in the aquarium. The details of the whole complex topic aren’t

important, since in an aquarium, only a small portion is significant, namely the breakdown of ammonia and nitrite by certain bacteria. These bacteria are necessary for the biofilter, and they themselves have three basic needs: surface area, nutrients, and oxygen.

Surface Area

Biofiltration bacteria do not live free in the water; they must attach to a substrate. They will grow on just about any surface—the glass, plant leaves, gravel grains. To encourage the large colonies that are needed, biofilters contain a medium that has a high concentration of microscopic surface area. High-quality activated carbon is probably the medium that contains the largest micropore surface area, but



Lava chips provide a perfect substrate for beneficial bacteria to colonize.

there are many other excellent media, including ceramic foam, foam sponge, and even the regular polyester fiber used for mechanical filtration. Anything that provides microscopic surface area and is in the flow of aquarium water will be colonized by the bacteria. This includes anything used for mechanical filtration, although the surface area in mechanical filters is typically not sufficient to handle the tank’s bioload.

Nutrients

One type of biofiltration bacteria eats ammonia, and the other type eats nitrite. If these substances are available in the water, the bacteria will form colonies and establish a working biofilter. In fact, it is by tracking the concentrations of these nutrients that the cycling process can be monitored.

Oxygen

Since these beneficial bacteria require oxygen, the biomedium must be provided with an uninterrupted supply of oxygen. There are some easy ways of doing this.

Oxygen can be provided simply by keeping a large volume of the aquarium water flowing over the biomedium.

Alternately, many biofilters take advantage of the fact that atmospheric air contains about 20,000 times the oxygen of the best oxygenated water. Therefore, a very thin film of water, only a few molecules thick, will,



Hang-on style power filters often have bio-wheels, which help to aerate and cleanse the water.

in the presence of air, maintain a much higher steady oxygen concentration—in effect, it’s a water surface without a body of water below it. As the bacteria use up the oxygen in the water, it is immediately replaced. This is accomplished by not submerging the biomedium in water; instead the water sprays, dribbles, or trickles over or through the medium, collecting below the medium for return to the aquarium. Because this type of filter has a body of water and a compartment that does not hold water but is merely kept wet, it is referred to—with just a touch of poetic license—as a “wet-dry filter.” The amount of medium needed to maintain an adequate bacterial colony is much less for a wet-dry system than for a flow-through one.





Several hang-on power filters include having the water drip onto rotating biowheels or through a sponge medium above the water line as the last stage. These effectively combine a wet-dry biofilter into the system.

How Does It Work?

In reality, it's not a tank that is cycled, it's a biofilter that is matured. We can therefore phrase the question of how cycling works as: "How does a biofilter mature?"

The best answer to keep in mind is: Slowly, over time. Patience is extremely important. Cycling can take as long as six weeks or more. It is a terrible temptation to have an aquarium all set up and running with only a couple of fish in it; the urge is to fully stock it, but you must resist the desire to get more fish.

The only tools needed are your ammonia, nitrite, and nitrate test kits. Read their instructions carefully and make sure you know how to use them. Somewhere there will be a chart, probably with three levels designated as: safe, concern, and danger. In the cycling process, many readings have to be in the midrange—more than negligible but not yet toxic. This is because in order for the bacteria to grow, they have to have food (ammonia and nitrite). If the levels were to get into the danger zone, cycling would continue, at a faster rate, but the fish in the tank would die.

Good Bugs

Bacteria are the predominant life form on Earth, whether measured by numbers, weight, or any other metric. Many species of bacteria are not just beneficial, but necessary—like the bacteria living in your intestines, without which you would die. Biofiltration bacteria are likewise required in a healthy aquarium.

The fish you choose to begin cycling your tank should be hardy types that can withstand the moderate levels of ammonia and nitrite that will occur. Zebra danios are excellent, as are guppies or platies. More sensitive species can be added later, when your aquarium conditions are as described in Stage Three.

The Cycling Process

Every tank is different, so we cannot give anything other than general guidelines, but the proper protocol for cycling a tank/maturing a biofilter contains three stages.

Stage One

Once the aquarium is set up, introduce two or three hardy fish. Do not feed

them at all for a day or two. This limits how much ammonia they will produce.

Test the water for ammonia. If it is not at the dangerous level, feed the fish a small amount.

The next day, test the water for ammonia. If it is not at the dangerous level, feed the fish a small amount. If it is in the danger zone, do not feed the fish, and perform a water change to bring the ammonia level back into the safe range.

After a week or so, check for nitrite. If there is none, wait a few days and test again. Once there is measurable nitrite, you have moved on to Stage Two.

Stage Two

Test the water for ammonia and nitrite. If they are not at the dangerous level, feed the fish a small amount. If either is in the danger zone, do not feed the fish, and perform a water change to bring the level back into the safe range. Repeat daily.

At some point the ammonia level will drop to zero. This indicates that the first type of bacteria have become established and are consuming all of the ammonia as it is produced. Nitrite will continue to rise until the second type of bacteria become established. Because a new biofilter is unstable, there may be an ammonia spike during this stage, so although it is not necessary to check ammonia every day when you check the nitrite level, you should occasionally also test the ammonia.

When the ammonia remains at zero and the nitrite begins to fall, nitrate will begin to accumulate. You can check that with your test kit. When both ammonia and nitrite remain at zero, you can move on to Stage Three.

Stage Three

At this point, many people make the mistake of thinking that cycling is done. This is true only in terms of the number of fish you have in the tank. That is, the biofilter is able to handle the wastes produced by those fish. When you add more fish, you will increase the bioload, and the filter may or may not be able to handle the increase without dangerous spikes in ammonia or nitrite.

Therefore, you should only gradually add more fish, a few at a time, until you have reached full stocking. Wait a week or so between additions, and test every other day or so. Never add more fish unless both ammonia and nitrite levels are at zero.

This gradual, three-stage protocol does require patience, but it ensures that you establish a fully mature biofilter without undue stress on your fish.

Isn't There an Easier Way?

Since this process is actually one of maturing a biofilter, not cycling a tank, this suggests that there must be an easier way to get a new tank started safely. There is: Borrow a biofilter! You can do this in several different ways.



Seeding a Biofilter

If you take some gravel or a few plants from an established aquarium and place them into your new tank, you will be “seeding” it with bacteria. This speeds up the maturation of your new biofilter, but it will still take time. If you have access to another aquarist’s tank, this is a viable option.

Using Mature Media

It is possible to completely shortcut cycling if you borrow a complete biofilter. By using either all the media or the entire filter from an established tank, you can start with a mature biofilter. You cannot, of course, remove the entire biofiltration system from a tank; it will crash, needing to be cycled again. Many tanks have more than one biofilter, and eliminating one is usually not a problem. Of course, the old tank from which the biofilter is removed should be monitored for a while to make sure there are no ammonia or nitrite spikes, in which case water changes should be performed to keep the fish safe.

Using a Matured Filter

An aquarist friend or a friendly retailer can help you with a very simple plan. Take the new filter you are going to be using on your aquarium and set it up on one of their tanks as a supplemental filter. The best scenario or protocol would be to put your new filter in an overcrowded tank (which will benefit

from your filter’s help) or one with a lot of heavy-feeding fish like large cichlids. Let the filter run on that tank for six weeks.

Then remove it and quickly—within a few minutes (so the bacterial colonies don’t suffer from that lack of water flow)—install it on your tank. Plug it in, and you have a cycled tank! It is important to place several fish—about a half to two-thirds of the final stocking—into the tank right away. This will ensure enough nutrients to maintain the bacterial colonies. If after a couple of



Biofilters come in an assortment of shapes and sizes. This bio-tower is one example that is commonly employed in a large system.



Siphoning your gravel on a regular basis is crucial to maintaining a healthy balance in your aquarium.

days your ammonia and nitrite levels measure zero, you can add the rest of the fish. You should still check the levels every few days until you are certain that the biofilter is stable.

Common Questions about Cycling

People encounter many problems when cycling a tank, and there is an enormous amount of bad and misleading advice being passed around about how to solve these problems. Cycling is certainly confusing. Let’s look at some common concerns.

What Is “New Tank Syndrome”?

New tank syndrome is an informal designation for a lack of understanding of biofiltration. It usually manifests as a newly-set-up aquarium, full of dead fish. When you fill a tank with water and then add fish, there is no biofilter, and within a couple days the fish all die from ammonia poisoning.

What about Water Changes?

Many people advise *against* water changes during cycling. They claim that they slow down the process by removing nutrients. Exactly! That’s what water changes do—they remove harmful substances. True, during cycling you want to feed your growing biofilter, but you don’t want to injure or kill your fish in the process!

Whenever ammonia or nitrite inch up into the toxic range, you need to perform a water change. Not a giant one, bringing the levels down to zero, but enough of a change to dilute the concentrations back into the safe range. This might indeed add a day or two to the cycling process, but, remember, patience is the key here.

Why Did My Ammonia Spike?

Often you will get a positive test for ammonia some time after it had stabilized at zero. An ammonia spike like this is often referred to as mini cycling. It may be caused by the instability of an immature biofilter,



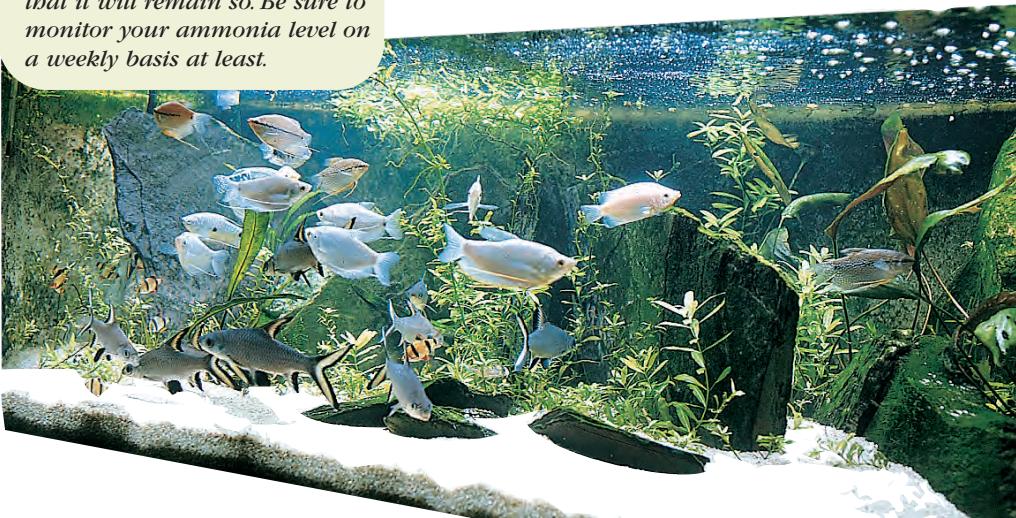


SMALL FRY

Learning Patience

Children are naturally impatient. It is especially difficult for them to have an aquarium with only a couple of fish in it, waiting for this invisible process called "cycling" to take place. Involve them in the testing of the water, explaining what the test results have to be for it to be safe to add more fish. This will break the anticipation up into daily segments and help the time to pass before the tank can be fully stocked. And you may be surprised how much your child learns during the process.

Just because an aquarium is well-balanced now doesn't mean that it will remain so. Be sure to monitor your ammonia level on a weekly basis at least.



which can vary from day to day in its ability to process wastes, but it can also be caused by an actual setback. If the tank got too warm or too cold, bacterial colonies may have died back, and they will require time to regrow. You may have added fish, or overfed a bit. Often the culprit is a dead fish wedged in where it cannot be easily seen.

The solution to this problem is the same as it is during cycling: do a water change to bring down the ammonia level, then test daily until things have again stabilized. When you do the water change, vacuum the gravel thoroughly and look around behind rocks and such for decomposing food, dead plants, or dead fish. As long as the existing fish in the tank look okay, they can stay in the tank. If they are showing signs of distress then they should be moved to a different, and more stable, setup.



You should be on the lookout for an ammonia spike whenever you add fish to the tank, use medications, or have anything happen that might affect your biofilter. During the initial stocking, adding only a few fish at a time is the best way to make sure you never overtax the biofilter.

What Is the "Gradual Stocking Method" of Cycling?

In this method, one fish is added to the tank at a time, with a week or so between additions. Because so little bioload is added at any given time, the ammonia and nitrite levels rarely get into the danger zone. It takes longer to cycle, but it is much safer.

This is also a way to cycle a tank that is going to contain only species that normally could not survive cycling. The only other option is to use a different species, a tough one that will cycle the tank and that you can then replace with the desired species.

How Can Someone Get Away with Not Cycling Their Tank?

They can't. Let me point out that cycling is something that *happens*. It isn't something that you do.

Despite the shorthand phrasing that we use, *you* do not cycle the tank (mature the biofilter), the tank itself cycles (the biofilter itself matures).

Someone who sets up a tank and never picks up a test kit or worries about adding fish and somehow lucks out and doesn't lose any fish might mistakenly say, "I never cycled the tank." No, he didn't, but the tank cycled anyway. That is, a biofilter developed, and due to dumb luck, it developed quickly enough to save the fish from death (though perhaps not from injury or suffering).

But Is There Any Way to Completely Avoid Cycling?

There will always be a bit of biofiltration bacteria in a tank—on the glass if nothing else—but there is one way to have a successful tank without a biofilter beyond that. That is to have a flow-through system, like many commercial hatcheries. In such a setup, each tank is fitted with an overflow. When water reaches a certain level, it overflows and goes down the drain. Above each tank is a valve which introduces fresh water into the aquarium 24 hours a day.



Using Your Test Kits

It is vital that you know how to use your test kits properly. Read the manufacturer's instructions carefully, and practice before you begin to cycle your tank. It is also useful to have two different kits and use one to check the other.

This type of system can be quite expensive to run, since you must have a constant, massive supply of water at the right temperature. Of course, if you have a geothermal well, as one commercial cichlid breeder I know does, you can eliminate all filtration and heating and produce extremely healthy fish in perfectly clean water with the only expense being running the water pumps.

The flow rate must be high for this to work, since all ammonia has to be diluted and swept out of the tank by the constant flow of clean water. When the flow is considerably less, a biofilter is required in each tank, and the setup is instead called an automatic water change system. It still keeps the water very clean, but the water exchange is too slow to keep up with ammonia.

So, yes, it is possible to avoid cycling

completely, but unless you have a flow-through system, cycling is mandatory.

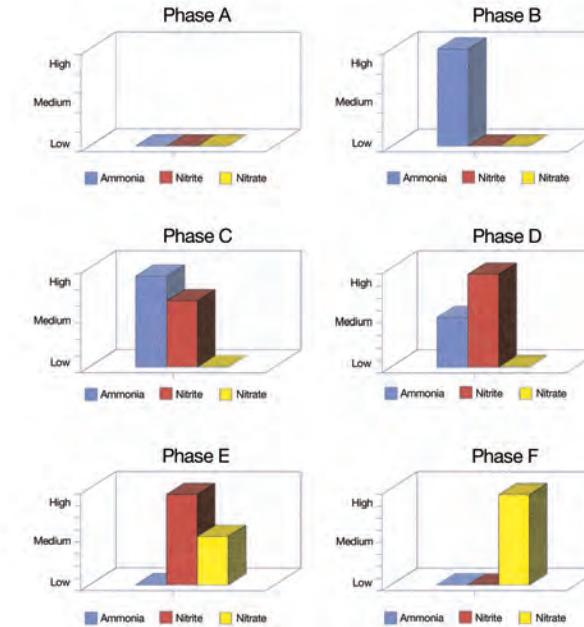
How High Can Nitrate Go After Cycling?

It is clear that some nitrate can accumulate in the aquarium without harming the fish. The disagreement comes when you consider just how much can accumulate safely. The decision should take into account the fact that although we can test for nitrate, many other substances such as trace metabolites, pheromones, and pollutants build up in aquarium water. We cannot test for these and they are concentrated by evaporation.

Nitrate levels, therefore, are an indicator of the overall quality of the water, but they are only one component. The ideal nitrate level is zero. Although that is rarely attainable, it is possible to keep the level quite low with regular large water changes. Your goal should be to keep it as low as you can, which will also keep down the level of other pollutants that you cannot test for. There is no such thing as too much water changing, either in volume or in frequency. Fish will thrive with 100 percent daily changes.

What about “Fishless Cycling”?
You can grow a biofilter without using fish in the tank to provide the ammonia to feed the system. Since there are no fish living in the tank, you can let ammonia and nitrite levels

Fig. 1.1



Cycling can be broken down into six basic phases (A-F). In phase A, all nitrogen levels are at zero. Phase B is indicated by a sharp rise in ammonia (blue). In phase C, the ammonia level is still high as the nitrite (red) level rises, too. Phase D shows the ammonia level beginning to drop as the nitrite

level climbs still higher. Phase E can be identified when the ammonia level has fallen close to zero, the nitrite level begins to drop, and the nitrate (yellow) level begins to rise. Finally, in phase F we see a marked decrease in both ammonia and nitrite while the nitrate level tests in moderate to high levels.

skyrocket, which greatly speeds up the process of cycling. So, how do you feed the bacteria?

You can use ammonia. Common household ammonia often contains perfumes, detergent, or other harmful substances, but if you can find pure ammonia solution, you can use that, about a capful. Or you can use a bit of ammonium chloride powder. When your daily tests indicate the ammonia

level has dropped, add more. That should also signal you to try testing for nitrite. If there is no measurable nitrite, add the ammonia and test for nitrite again the next time the ammonia drops.

Ironically, you can also use fish for fishless cycling. A chunk of fresh or frozen fish flesh, added to the tank, will decompose, producing plenty of ammonia to feed the bacteria.

