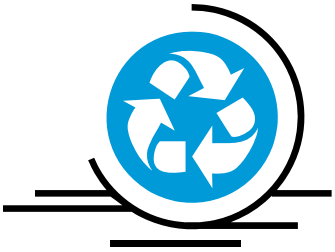
Aquaponic Equipment

The Bio Filter



By Rebecca L. Nelson

There are three crops in an aquaponic system, the fish, the plants and the invisible but crucial beneficial bacteria. It is the bacteria that convert the toxic components of the fish waste into a form of nutrients usable by the plants. Without the beneficial bacteria, an aquaponic system will fail. There are several types of bacteria in aquaponics, and each performs a very specific function (these will be explained later in this article). Fortunately, given the right environmental conditions, the bacteria will thrive in an aquaponic system.

There is nothing magical, artificial or unhealthy about the bacteria. To the contrary, they are completely natural, exist in all bodies of water on earth and they are required to sustain life on our planet. In fact, there are many beneficial bacteria that we can't life without, not just those that live in an aquaponic system.

Fish excrete ammonia through their urine and, to a lesser degree, through their gills. Ammonia also comes from the solid fish waste as it breaks down. Ammonia, even at low levels, is toxic to most fish and aquatic organisms. In a fish tank, the fish are stocked densely resulting in higher ammonia levels than in a lake or pond.

The nitrification process is that in which autotrophic bacteria use oxygen in a two-step process to first convert the toxic ammonia (NH_3 or NH_4+) to nitrite (NO_2 -) and then the nitrite (NO2 -) is converted to nitrate (NO_3 -). Specifically, the bacteria *nitrosomonas* sp converts ammonia to nitrite and the bacteria, *nitrobacter* sp, converts nitrite to nitrate.

Both the ammonia and nitrite are toxic to fish at fairly low levels. The Nitrate is much less toxic and typically tolerated by most cultured species until it reaches very high levels. Controlling nitrate in aquaponics is accomplished by the plants.

In another natural biological process, heterotrophic bacteria convert solid fish waste to ammonia and other elements. These natural processes are a perfect example of earth's recycling. This is one of the many reasons aquaponics has become such an important and effective tool in teaching science and agriculture in schools around the world.

So, what is a bio Filter?

A bio filter is simply a place for the bacteria to colonize. It provides large surface areas, proper temperature, pH and dissolved oxygen levels. In raft and media-filled bed aquaponic systems, a separate bio filter is not usually used because the rafts, media, tank walls and all other surfaces in the system provide sufficient area for the bacteria. In an NFT (Nutrient Film Technique) system, a separate bio filter is required because the NFT channels do not provide adequate surface area.

Another reason some growers will add a separate bio filter to an aquaponic system is so that, if for some reason they are not using the plant grow bed but are still running the fish tanks, there won't be a lack of bio filtration.

In a recirculating aquaculture system (RAS), the bio filter is a critical piece of equipment because the fish farmer does not have the benefit of the large

surface area of grow beds to provide the habitat for the bacteria.

A bio filter is usually a canister, tank or barrel of some sort that holds a porous media that is heavily aerated. The water from the fish tank runs through this bio filter where the ammonia will be efficiently converted to nitrite and then to nitrate.

How is Nitrification Related to pH?
In aquaponics there is a bit of a compromise between the needs of the fish and the needs of the plants when it comes to temperature and pH. It is the environmental needs of the bacteria that a grower should try to accommodate to keep their system healthy. Nitrification is at its peak when the pH is at 7.0 or a little above. Coincidentally, this is the compromise point between the needs of the fish and the needs of the plant.

When the pH drops below 7.0, nitrification slows down and at a pH less than 6.0, nitrification nearly stops. The nitrification process generates nitric acid, which will lower the pH of the water. This is the reason that most aquaponic growers need to raise their pH to maintain neutral. This isn't the case with all aquaponic systems, though, because the variance of pH is dependant on other factors as well, such as the alkalinity and buffering capacity of your water, the chemistry of your water and the temperature.

The research scientists at the University of the Virgin Islands, as well as many growers who have studied UVI's techniques, use calcium hydroxide alternatively with potassium hydroxide to raise the pH. The benefits of doing so are twofold. One is that the pH is raised to maintain neutral and, two, is the resulting supplementation of calcium and potassium, which are sometimes at deficient levels for plant growth.

Where do the bacteria come from?
The bacteria we have discussed are naturally occurring and will ultimately colonize the media in the bio filter as well as the tanks and pipe walls. The speed of this process is dependent on temperature, pH, salinity, surface area and flow rate.

Some growers will jump start a system in one of two ways: 1. Prior to adding the fish, they will add ammonia to the water in the fish tank. This will encourage the growth of the bacteria colony and will begin the nitrification process. 2. They will purchase a bacteria mix from an aquaculture or aquarium supplier and add it to the water once the fish have been introduced.

I don't really see the necessity of either of these methods. The first can cause a setback if too much ammonia is added and the second can be costly with no guarantee of healthy bacteria. As mentioned, the bacteria will naturally colonize the system once fish and, as a result, ammonia are present.

How do you know if your bacteria are working?
Since you can't see the bacteria, you can't measure them or count them, or monitor their health. The way that you know your bacteria and, ultimately, your aquaponic system, is healthy is to test the levels of ammonia, nitrite and nitrate. When you introduce fish into a body of water, you will see a rise in ammonia for about the first 10 days. Then, you will notice the nitrite level rising and the ammonia levels starting the fall as the *nitrosomonas* do their conversion. After another 10 days or so, you will see the nitrate level rising and the nitrite level falling as the *nitrobacter* get to work. After the first 20-30 days, your system will stabilize and the nitrification cycle will naturally continue.

Do you need a bio filter?
Essentially, your whole aquaponic system is a bio filter and, unless you are using NFT to grow your plants, you will not need a separate bio filter. It is important, though, to understand the role of the bio filter and the bacteria so you better understand what is happening in aquaponics and can better troubleshoot problems with water quality and fish and plant health.

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