Anoxic Filtration – Is it a Filter? Part 1

This article has been written so as to be as easy to read as possible for those who would like the simplest possible explanation of the very complex subject of anoxic filtration. (For simplicity, the baskets used in the anoxic filtration system will be referred to throughout this article as “baskets” or “biocenosis baskets” but their proper name is Biocenosis Clarification Baskets”).

Take a planting basket, fill it with cat litter, then scoop out a depression from the center and fill that depression with an aquarium plant fertilizer called Laterite. Put a plant into the basket if you wish, but it is not necessary.

If it is that simple and inexpensive to make a biocenosis basket, why are more koi keepers not using the anoxic filtration system? Possibly the answer lies in the fact that it is rare to find a koi keeper who actually understands what anoxic filtration actually is, what it does and how it works. The reason for this lack of understanding should immediately be obvious. Already, I have used three words that many koi keepers will find new and mysterious. What is Laterite? What is a biocenosis basket? And isn’t anoxic something to do with anaerobic sludge where harmful bacteria can live?

If it were possible to describe the anoxic system without using such words I would do so, but, whilst it is easy to build the system, the way it works is extremely complicated. So let us begin by explaining what Laterite, biocenosis and anoxic mean.

• **Laterite:** This is easy enough to understand. It is simply a clay-based material that is rich in iron. It is used in tropical fish tanks as a plant fertilizer and can be bought from tropical fish dealers.

• **Biocenosis:** This is a scientific term for a place where different biological processes take place, each process being of mutual benefit to the other processes.

• **Anoxic:** Anoxic does not mean the same as anaerobic. In an anaerobic region there is a complete absence of oxygen. In an anoxic situation, there is oxygen present but it is at a very low level. In a biocenosis basket there is always a low level of oxygen. Levels are typically between 0.5 ppm (mg/L) and 2 ppm. This is the key factor that will influence a situation where anoxic filtration can occur. The presence of an extremely low level of oxygen is crucial to the

system as will be described later. In passing, it might be worthwhile to contrast the oxygen level in a biocenosis basket with the oxygen level in the pond itself. The absolute minimum acceptable oxygen level in a koi pond is 6 ppm, although 7 ppm is more often recommended as a safer minimum to adopt and, in practice, it should be at saturation level (as high as is possible at any given temperature).

With the first few terms explained, it should now be possible to move on to a better understanding of how the anoxic filter system is quite unlike any filter system that is commonly in use by pond keepers. There will be more complicated terms as the description unfolds, but each will be explained as we explore the system. To contrast anoxic filtration with conventional filtration, it is first necessary to understand how biological filters actually work.

Conventional Biological Filtration

Fish continuously excrete ammonia, which is toxic to fish, and so it has to be removed from the pond water before it can cause them harm. We all know this. Any well-designed conventional biological filter system will be effective at taking this ammonia and converting it, first into nitrite, and then into nitrate by a process called the “nitrogen cycle.” This is also well known. Having achieved the conversion of ammonia into nitrate, the task of a conventional biological filter is complete. No further biological action to remove the nitrate takes place and so the level of nitrate in the water slowly rises. This is the first disadvantage of conventional bio-filter systems. Nitrate is nowhere near as toxic to koi as either ammonia or nitrite but that doesn’t mean that they are not affected by it. Hard scientific research on this subject is difficult to come by, but there is plenty of anecdotal evidence to show that koi kept in low nitrate ponds show better growth and color development than those kept in a pond where the nitrate level has been allowed to rise. Easier to prove is the affect that nitrate has on algae of all types. Nitrate is a plant fertilizer. A rising level will encourage blanket weed and the kind of algae that turns water green. Water changes will help but, even after a 10% water change, the nitrate level will still be 90% of the original value, and, as more ammonia is converted, the nitrate level will soon begin rising again.

There is a second problem with some conventional biological systems, which is that the biological media can become anaerobic (no oxygen at all). This will not occur with moving media such as fluidized sand or aerated K1, but where the media is static, water flowing through it carries suspended particulate matter as it passes through. This will settle within the media,

and, over time, can cause it to block. Water will not easily be able to pass through blocked areas and will tend to bypass them. The water will find it easier to flow through areas that are not blocked (yet!).

Water flowing through media carries oxygen to the bacteria that are living within it. As the flow through a particular area reduces, the bacteria in it will find that there is less and less oxygen in their environment. The bacteria that have been oxidizing ammonia, firstly to nitrite and then to nitrate, will have been using a great deal of oxygen to do this. As the media becomes clogged, they will find that they no longer have the oxygen available to carry on this process. There are bacteria that need oxygen as part of their biochemistry, but, in some ways, can be thought of as being far more clever than we are. If we are deprived of oxygen, we soon die. These bacteria normally take the oxygen that they need directly from the water surrounding them, but if there is no oxygen in that water, there is a way they can get it. They can take oxygen from nitrate. Nit

NO3) is the end product of the nitro-gen cycle, (as far as koi keepers are concerned). It consists of one atom of nitrogen joined to three atoms of oxygen. These bugs can take away the atoms of oxygen from nitrate. In doing so, they reverse the nitrogen cycle.

Our two favorite nitrogen cycle bugs, nitrosamines and nitrobacteria, will be as busy as ever converting ammonia to nitrate in the aerobic areas of the biological filter, but bugs that can live in anaerobic conditions will rapidly colonize the anaerobic areas and will become equally busy taking the oxygen that they need from the nitrate that has just been produced by their cousins. This will result in that nitrate being converted back to ammonia again before it leaves. This is a completely pointless exercise, yet it is exactly what is happening in many filter systems where the biological media is not clean. At least part of the good work being done by the bugs in the oxygen-rich areas, is being undone by bugs in areas that are deprived of oxygen.

The anoxic filtration system was designed and has been developed over many years by Kevin Novak, Ph.D. and it addresses both these problems. The anoxic system does not rely on converting ammonia to nitrite and then into nitrate. With the anoxic system, ammonia is either converted directly to nitrogen gas, (more correctly called di-nitrogen), by bacterial action in the unplanted baskets, or it is taken up by plant roots in baskets that also contain plants. It is well known that plants “like” to feed on nitrate. What is less well known is that plants actually “prefer” ammonia as a food source, and will take it directly from pond water if it can be presented to their roots in the correct way. The process that causes this to happen will be described in detail in Part 2 of this article, but for now, please just accept that ammonia molecules are attracted into the baskets by the Laterite.

Another important feature to understand is that it is only the ammonia molecules that are drawn into the biocenosis baskets. Obviously, water floods into them when they are immersed, but after that, water does not actually need to flow through them in order to filter out ammonia. The Laterite in the center of the basket only draws in ammonia molecules; it doesn't draw in water molecules. This directly addresses the second possible problem that can happen with some of the static types of conventional filter media I mentioned earlier – that suspended particulates can clog media and it will then become anaerobic.

Critics that have not taken the trouble to understand how the anoxic system works, often wrongly describe it as a "bog filter, full of nasty anaerobic bacteria." They warn that the baskets are a breeding ground for parasitic bugs that can then spread to your fish. In fact the direct opposite is true. Biocenosis baskets cannot clog because, if no water flows through them, there is no way that debris can be carried inside. On the other hand, if water flowing through conventional media does not have every speck of debris filtered out of it, there will always be the risk that sludge will settle inside and block the media. So, far from a biocenosis basket being a "bog filter," it is more likely that this label could be applied to a conventional system that has not been kept sufficiently clean!