KALDNES MEDIA FOR BIOLOGICAL FILTRATION

Steve Hopkins
reprinted from
Koi Talk, Newsletter of the Hawaii Goldfish and Carp Association
Jult, 2006

Kaldnes filtration media is a versatile, efficient, easy to use, and expensive product. It was developed for use in the sewage treatment industry, but has become popular with koi keepers, who are still finding new ways to use it. This is not an advertisement, just some random thoughts about little plastic wheels.

The Kaldnes Moving Bed ™ is a patented filtration process developed by Professor Ødegaard in Norway during the late 1980's. It is basically a biofilm process. You know "biofilm process" – bacteria growing attached to filter media changes toxic ammonia to nitrite and nitrite to non-toxic nitrate. These biological filters are the heart and soul of fish pond and fish tank water purification.

There are all sorts of filter media being used. Since the amount of biological filtration going on is partially a function of the amount of surface area available for bacteria to grow on, you want a lot of surface area in a small volume of material. In the old days, everyone used lava rock (cinders) or other gravel as the filter media for the bacteria to grow on. Small gravel has more exposed surface area per cubic foot than large gravel. However, there are practical limitations to how small the gravel can be. If the gravel pieces are really tiny, then debris becomes trapped in the crevices between adjacent pieces and water can no longer flow through. The flow may be completely restricted but, more often than not, the flow "channelizes". When channelized, all the water flows through just a couple of small passageways which are kept open by the high water velocity. If water cannot flow through to deliver ammonia and oxygen to the bacteria throughout the filter bed, then the bacteria cannot do their job.

You noticed that we said the water has to carry ammonia and oxygen to the bacteria. These are aerobic bacteria, meaning they need oxygen to survive. When they do their job, they use a lot of oxygen. The ammonia molecule has a nitrogen atom attached to hydrogen atoms. When the bacteria have completed their job, the resulting nitrate molecule has that same nitrogen atom attached to three oxygen atoms. All those oxygen atoms must be delivered by the water to the bacteria. In the gravel filter, all the oxygen may be consumed by the time the water has traveled about four inches through the rock. There are several ways to overcome this problem of oxygen consumption. One way is to use a wet-dry or trickling tower filter where the filter media is not actually under water, but has a continuous supply of water being pouring over it. But, that's a different article for a different month of *Koi Talk*. The other way to supply oxygen is to put air diffusers under the filter material with the bubbles rising up through it.

So, the major drawbacks to using rock as a filter media is that it is heavy, it's very hard to clean, it packs tightly so you have to use large enough rock to have large crevices which will not clog, and the large rock does not have a huge surface to volume ratio. Number 3 Coarse Bluestone from the quarry has a surface area of about 75 square feet per cubic foot of rock. But with that said, we have to mention that there are a many gravel bed filters which have been operating very well on koi and goldfish ponds for decades. If it's not broke, then don't fix it! One thing about gravel, it's inexpensive. Blue stone costs less than $2 per cubic foot, $1.10 when you buy it by the cubic yard. That's only $1.50 per 100 square feet of exposed surface.

Today, most new filters use some sort of plastic media. There are Bioballs. Bio-Fill, Bio Barrels, Bio Strata, Bio-Chem Stars, and Biomate. Of these, the PVC shavings or ribbons, called Bio Fill, gives the most surface area for the money - about $12 per 100 square feet of exposed surface. Add about 35% for shipping charges. Bio Fill is sort of springy so the spaces between ribbons remain open and there is about 250 square feet of surface area per cubic foot of media. A popular media for koi ponds is Matala mat or Japanese mat. This is the rigid green or blue mat that comes in sheets and is about 1½ inch thick. The cost is about $25 to $30 per 100 square feet of exposed surface area before shipping. Because the individual strands bonded together in the mat are small, there is probably a more uniform water flow through the material than with the PVC ribbon.

Then, there are beads. Plastic beads have about 400 square feet of surface area per cubic foot of media. Companies making plastic pieces and parts bring in plastic "resin" which is melted and injected into molds to create their product. This "resin" is nothing more than small plastic cylinders

about one-eighth inch in diameter and one-eighth inch long. This resin is inexpensive, but you may have to buy a ton to get the low price. Beads sold for use in bead filters is much more expensive, but little different from plastic resin. Like very small gravel, plastic beads pack together with very small crevices between the adjacent pieces which can clog easily and restrict water flow. The debris lodged between the beads make the beads clump together. This is why beads are typically only used in specialized filter housings which can break up the clumps during the backwashing process. Because the outside of the bead is smooth, the attached bacteria can be scraped away when the beads are agitated, such as during backwashing. However, bead filters have some unique advantages which we'll talk about more in a later article.

Kaldnes media looks like little plastic wheels about three-eighths of an inch in diameter and one-quarter inch wide. It has 260 square feet of exposed surface per cubic foot of media. About 65% of the surface area is "protected" in that the biofilm cannot be scraped away when the media is agitated. Kaldnes costs about $40 per cubic foot or $15 per 100 square feet of exposed surface. Again, add about 30% for shipping. The real beauty of this stuff is that (1) it's slightly buoyant and (2) there are ridges and spaces within the wheel which protect the bacteria from being scraped away when the media is agitated. For biological filtration, Kaldnes media is designed to be continuously agitated and kept in motion – hence the trademarked Kaldnes Moving Bed process.

A Kaldnes filter is some sort of tank or other vessel which is up to 65% full of the plastic media. When the tank is filled with water, the Kaldnes floats up off the bottom leaving a vacant space below. The tank has an inlet port and an outlet port. There may be a third drain port at the bottom for cleaning waste. All the ports are screened to prevent loosing the media. The stiff black plastic mesh with an opening size of ¼ inch works well for retaining the media and is available locally. Below the media, in the center of the tank, is an air diffuser (air ring or air stones). The tank is continuously aerated. The rising bubbles in the center of the tank lift water and pieces of the media with them. As the media rises in the center of the tank, it sinks around the perimeter creating a boiling or rolling effect (see schematic figure). This constant motion does several things. The oxygen is replenished. Debris does not become trapped within and between the pieces of media. There is a continuous and uniform flow of water around and through each piece of media to keep delivering water, ammonia and oxygen to the bacteria. The movement makes the media self-cleaning. The mass of Kaldnes media creates almost no resistance to flow. As long as the inlet and outlet ports, and their screens, are large enough to accommodate the flow, the Kaldnes moving bed filter can be operated with gravity flow into and out of the vessel, and with almost no loss of head. It's an elegant system.

Kaldnes media has been used to replace gravel and other types of media in some applications. There are also some high-end koi pond filters which were designed specifically to utilize Kaldnes; such as the popular and very expensive Nexus™ filter. For Kaldnes media in a moving bed, you will need 3.2 cubic feed of media per pound of feed being added to the pond daily. To put it another way, each cubic foot of media will support 20 pounds of fish which are being fed at a rate of 1.5% of their body weight per day.

This discussion focuses on the K-1 style of Kaldnes media. There is also a K-3 style which is larger. The K-3 style is about 10% less efficient, but the larger size makes it easier to use in some applications (sewage treatment for example) where the amount of solids could clog the screen used to retain small K-1 media.

It is possible to use too much aeration or too little aeration in the filter vessel. For every cubic foot of Kaldnes in a moving bed filter, you will need to supply about 0.5 cubic feet per minute of aeration to keep the media "rolling". You can measure the aeration rate by capturing the bubbles in an inverted bucket filled with water and timing how long it takes the bubbles to displace all the water.

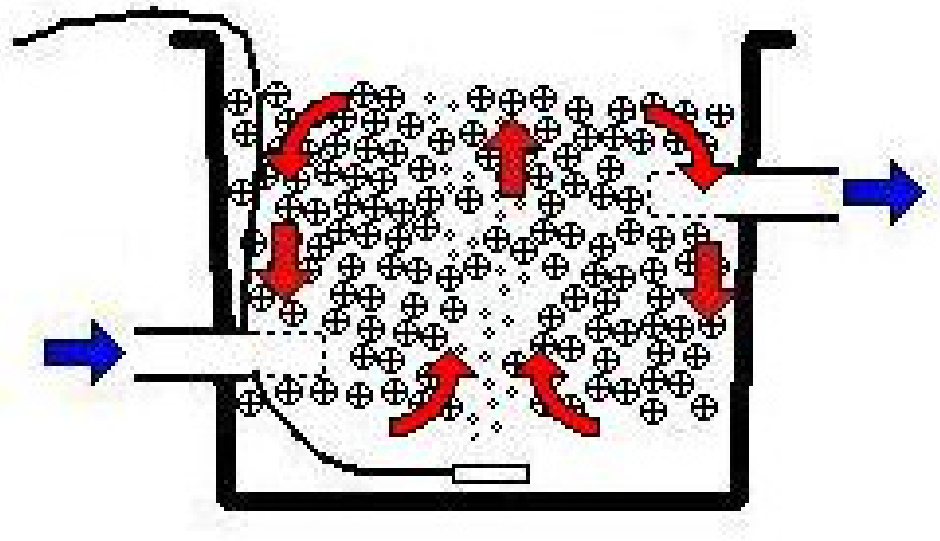
People who began using Kaldnes media in koi pond filters have reported a few details which deserve repeating….

First, when the media is new, it tends to be a little more buoyant than you would like it to be. A layer of floating media several feet thick, may extend above the surface of the water several inches. When mature, the media will not rise above the surface. The extra buoyancy will make it very difficult to get it to "roll" when aerated. To speed up the process of maturing, you can treat the media with one gram of potassium permanganate per three gallons of water. Of course, you would not want to expose the pond water or the fish to the potassium permanganate unnecessarily. The extra buoyancy may be the result of waxy release agents used in the manufacturing process. The potassium permanganate treatment seems to speed up colonization by the nitrifying bacteria as well.

Secondly, when new media is put into service, the color will turn from white to brown as the bacteria colonize the surface. After a month or so, and after the filter is “cycled” and performing well, the media will turn from brown to a light beige color. It is thought that the bacterial biofilm becomes so thick that the outer layer sloughs off. Even though the thickness of the biofilm is reduced and the color changes, the media continues to perform as before and there is no increase in ammonia or other change in water quality. All media shed biofilm as it grows and becomes too thick to be held in place on the surface of the media. Some types of media and systems shed bacteria biofilm mainly in the cleaning process. Kaldnes is essentially self cleaning and continuously cleaning. However, this means that shed biofilm is carried with the water back to the pond or to the next stage in the filtration process. All biofilters should be located after the mechanical filter (if one is used) to minimize the amount of debris which could become trapped and smother the biofilm.

Thirdly, some feel that Matala mat (Japanese mat) is more “resilient” than Kaldnes media. Kaldnes can handle a higher feed rate per unit area when the feed rate and other conditions are stable. However, if the feed rate is increased abruptly, the bacteria population in Matala mat will quickly adjust to the larger amount of ammonia. The bacteria population in Kaldnes takes longer to adjust. This could be the result of the Matala mat maintaining a thicker layer of biofilm. Matala can also be operated with air bubbles moving up through the media. This will provide oxygen, but does not significantly clean it.

Kaldnes and the moving bed biological filter is an interesting concept and easy to use.



schematic of Kaldnes Moving Bed biological filter