Constructing a Full-Size Biological Pond Filter
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Last year I designed a small biological filter for my pond. It was supplemented with a traditional canister filter which was designed for pond use. I submitted an article for the design competition for this filter (March, 1992 issue).

As winter progressed, I thought about designing a full-scale biological filter which could be used without the traditional canister filter. I have completed the filter, and submit the enclosed article to describe filter construction and the principles underlying biological filtration for the pond.

When I was a boy, I used to enjoy fishing with my uncle. While all types of fishing appealed to me, my favorite place for fishing was a small stream not far from my uncle's house. I enjoyed the sound of running water, the pebbles on the stream bottom, and the white-water effect of the current as it passed over shallows.

One of the things which I associated with white water areas was the cleanliness of the water in the rapids areas. Usually, the white water area was composed of a series of larger pebbles or stones immediately preceding the faster water. In the area of the fastest water movement, the pebbles were very small, and looked similar to the gravel found in an aquarium. Just past the white water area were large, still, pools of water. It was in these still pools of water, which were often full of plant growth, where the largest fish could be found.

From these early observations of a small stream, I have developed an interest in ponds and water gardening. The sound of running water rippling down a stream bed still remains enjoyable, after all these years. I have tried to emulate nature's filtration process in designing systems to work in a man-made pond. Rapids serve as a natural filtration system for a small stream. The turbulence of the water in a rapids area tends to add dissolved oxygen to the stream (as I later learned large amounts of dissolved oxygen as required for aerobic bacteria to start the nitrogen cycle). Large pebbles tend to trap suspended particles in the water. Smaller pebbles placed in the streambed serve as an area where bacteria can flourish. These bacteria tend to break down ammonia and suspended solids into less harmful nitrates and nitrides. The heavily planted areas located in deeper pools also provide oxygen and further filtration of the water (in addition, the plants convert nitrates into nitrides, which are less harmful to fish). The oxygen carrying capacity of the stream enables larger predatory fish to hold in the deeper pool area.

The design for a biological filtration system should be developed so that it imitates a natural system. A pond filter should therefore provide rapidly moving water to allow for oxygenation, a method to move large suspended particles, a medium to foster growth of bacteria, and plants which add oxygen and promote final filtration (and removal of nitrates). In order to accomplish the filtration steps mentioned above, a filter should be constructed which has several chambers, each of which will provide a necessary step in the filtration process.

An ideal container to house the filter is an LDPE polyethylene storage container, having a capacity of between 15 -25 gallons. Several containers can be linked together using PVC pipe to accommodate additional steps in the filtration process. In-feed from the pond to the filtration system can be accomplished through gravity, or, if the pond is large enough and warrants additional assistance, and in-feed pump can be used. Aquariums can also be used to house a biological filtration system, but may be damaged in areas which experience less temperate climates.

The first stage in the filter should be designed to remove large particles which are suspended in the water. Large pieces of Japanese filter matting (usually composed of nylon or plastic fibers), which go by various trade names, are ideally suited for this stage of the filter. These pieces can be arranged in several rows, so that each row provides additional media to remove suspended particles.

The second stage of the filter should also be designed to remove suspended particles, but should also act as a place for bacteria to congregate. DLS-type material is ideal for this stage of the filter. If DLS is used, try to allow for several rolls to fit in the filter chamber, so that bacteria colonies can be readily established. (Author's note – the manufacture of filter brushes since this article was first written, make this an ideal medium for the second stage of the filtration system).makes this an ideal

The third and fourth filter stages should be constructed of material which encourages bacteria formation, while providing successively finer levels of filtration media. Recently, plastic filter rings have been developed for use in marine aquaria. These filter rings (balls or blocks are commonly seen) serve wall as a housing for bacteria growth, and can be added to the third filter chamber.

The fourth chamber can use sand, gravel, or small pebbles to provide a final polishing for the water. The fourth and final chamber should house an out-feed pump (or be gravity-fed) which is connected to a PVC pipe and discharged back into the pond. Discharge rates of 300 to several thousand gallons per hour are possible, and are dictated by the size of the pond.

As I mentioned earlier, a final filtration step is plant growth, particularly oxygenating plants. An effective method pf providing plant growth which will act as a filtration medium is to construct a small holding pool for the discharge of the filtered water. This holding pool should not be part of the main pond, but should be connected to the main body of water by a waterfall and stream arrangement. By building a holding pool, you can provide a final filtration step and ensure that your plants survive (goldfish and koi can destroy all but the hardiest plants). An ideal plant for this type of pool would be water lettuce or water hyacinth, since both have an elaborate root system which will further filter the water (I would also add bacobus to this list – I was not familiar with this type of plant when the article was first written). A secondary benefit of a holding pool is the aeration which will be provided by the combination of the waterfall and plants.

Design of a good system does not mean that maintenance can be ignored. Indeed, maintenance of the system is essential for proper water chemistry. Partial water changes, cleansing of the filtration medium (stages 1 and 2 – please do not clean the final 2 stages frequently, since this will disturb the bacteria colonies developed in these stages), and removal of yard debris are all essential elements of good pond maintenance.

Finally, take time to experiment with design elements of a biological system. Some filtration media are better than others – try different media until one serves better than the others. You might even go to a local stream to see how the best designs function – nature has perfected this technique over millennia.

Author's note: When this article was first published, multi-stage filtration systems were not readily available, and had to be constructed by the hobbyist. It is gratifying to note that many of the topics covered in the article are now accepted as 'the way" filtration works, and the "way" to design good filtration systems. While I would encourage hobbyists who have the time to build these types of systems, it is too easy, affordable and convenient to purchase systems "out-of-the-box" for most hobbyists. Many manufacturers build multi-stage filtration systems, and I would recommend Vortex units and "Nexus" units as being state-of-the art at the time of this writing (April, 2005).