Freshwater Aquarium Filtration

Filtration is absolutely necessary for the health of your aquarium. I have read accounts where people claim to run their tank "naturally" with heavy bioloads and no filtration or water changes. I am skeptical about all such stories. Because an aquarium is a closed system, the animal waste and food added by the aquarist result in the accumulation of toxic chemicals in the water. Without adequate filtration a tank with even a moderate bioload (number of animals in the system) will quickly foul and kill all of the inhabitants. For a filter-free system to work, there would have to be almost no fish in the aquarium, or daily water changes. The former would slow the accumulation of wastes to such an extent that the bacteria growing in the gravel could probably keep up with it, while the latter constantly removes waste through water changes. Since almost no aquarist is willing the stock their tank so lightly, or submit to daily water changes, there is really no such thing as a filter-free or maintenance-free aquarium.

Now it's time to talk filters. There are three modes of filtration, and any filter you are considering for your tank should do all three. The three modes are mechanical, chemical, and biological. Mechanical filtration uses foam or filter fiber to remove large particles, like uneaten food and fish excrement. Mechanical filters are graded from coarse to fine, with fine filters trapping the smallest particles. Chemical filtration includes activated carbon and the various ion exchange resins. Activated carbon traps dissolved organic compounds that are not removed by any other means (except water changes). Ion exchange resins are specific for one type of ion. Separate resins are available to remove copper, nitrate, phosphate, and silicate. Except for the copper resins, most freshwater aquarists will have little need for ion exchange resins. Finally, biological filtration uses colonies of helpful bacteria to break down the waste products produced by fish and overfeeding. Fish waste and food ultimately break down to ammonia (NH_3), which is extremely toxic to fish even at low concentrations (~5-10ppm). Some bacteria are able to metabolize ammonia and break it down into nitrite (NO_2^-). Nitrite is also very toxic, though slightly less so than ammonia. A second type of bacteria are able to convert nitrite into nitrate (NO_3^-), which is much less dangerous. In very high concentrations even nitrate can kill fish, but it is rare for a well-maintained aquarium to reach such levels of nitrate. While fish can endure some level of ammonia and nitrite, it is not conducive to the long-term health of the fish. Even in sublethal doses, these pollutants are still a source of stress, and in an aquarium any source of stress weakens the fish and makes them vulnerable to opportunistic bacterial and fungal infections. This is why an aquarium must be fully cycled before adding fish. The shock of moving into a new home is stress enough without having that home be toxic as well!

So what is the best filter for an aquarium? Basically, there is no "best" filter. Any filter that provides all three modes of filtration will do a good job for you provided it is powerful enough to handle the size of your tank. But if just about any filter is good, then how do you choose? Luckily only a few criteria affect your decision. First, the filter needs to be powerful enough for your aquarium. A good rule of thumb is that the filter should turn over the entire volume of the tank 5 to 10 times every hour. So for a 30 gallon tank you would need a filter capable of moving from 150 to 300 gallons per hour (gph). Next, the ease of operation and maintenance are important factors. If a filter is a pain in the neck to clean and maintain properly, chances are you won't do it as often as you should. Poor filter maintenance reduces the efficiency of the filter and thus the health of your fish. The last factor is price. Be sure to consider not only the price of the filter, but also the cost of the media. Remember that "you get what you pay for" applies here, so avoid anything that seems exceptionally cheap.

There are a huge variety of filters to choose from, but four general types are the most common. These are undergravel filters, canister filters, power filters, and wet/dry or trickle filters. Undergravel filters consist of a plastic support that sits under the substrate of the aquarium, creating a space of water beneath the gravel. Two to four plastic pipes rise from the corners of the plastic plates, usually in the back corners, with air stones driven by a small air pump to create water flow. The slow flow of water drags detritus and debris down through the gravel where bacteria can break it down. The advantages to undergravel filters is that they are very cheap and easy to setup and run, and the aeration helps keep dissolved oxygen high. One disadvantage is that they normally do not do chemical filtration. Also, not all the waste dragged through the gravel is broken down, so it accumulates. This requires one to scoop out all the gravel two or three times a year to clean the filter - not fun for the fish or the aquarist! Personally, I think they are ugly too, with all of those tubes rising from the gravel. For these reasons undergravel filters are becoming less common.

Canister filters are a far superior choice, in my oppinion. These units consist of a canister (go figure) and pump with a siphon tube to pull water out of the tank and a return tube to pump the water back in. The typical canister normally contains some type of coarse mechanical media, like ceramic "donuts" or very coarse fiber, some chemical media like carbon, some porous glass or stone for biological filtration, and finally some very fine filter fiber. So a canister filter actually does all three types of filtration. Most canister filters are very thorough and do a great job keeping aquarium water clean. The downside to these filters is that they tend to be expensive, use expensive media, and if not maintained well they can become nutrient traps. This means that all of the fouled filter media actually begins adding nitrogenase waste back into the water instead of removing it. Algae blooms and poor water quality are the result! Also, since canisters

are completely closed, they do not oxygenate the water so it becomes necessary to add an airstone or perhaps a small water pump to aggitate the water surface. Overall though, when properly maintained, a good canister filter is hard to beat. My personal experience has made me partial to Eheim filters since they are well-made and do a great job. I have one Eheim canister that I got as a kid. I ran it for 3 years, then put it away for about 10 years, dug it up 6 years ago and it's been going strong ever since!

Power filters normally hang on the outside of the tank and use a pump to pull water up into the filter. The water then passes through mechanical, chemical, and biological media in various configurations, then spills back into the aquarium. These filters are rapidly gaining popularity with aquarists because they are efficient, slightly less expensive than canisters, and a dream to maintain. Since they are exposed to the air they help oxygenate the water. The oxygen-rich water helps support huge populations of nitrifying bacteria making power filters some of most efficient biological filters. My experience with the various Marineland® biowheel filters has been excellent. The biowheel is basicaly a paddle wheel made of pleated material that gives the bacteria someplace to grow. Water spills over the biowheel on its way back into the tank and ammonia and nitrite are removed on contact. I have seldom had problems with ammonia or nitrite in any of my tanks with biowheel power filters. I am not endorsing any particular brand here, or saying that biowheels are better than other power filters; just that I have had good success with them.

The last type of filter we will discuss here is the wet/dry or trickle filter. These filters are not as popular as the others because they can be expensive, and they are probably most applicable to large tanks. Wet/dry filters are basically a second tank, or sump, that sits below the display tank. Water comes into the filter either through plumbing that is drilled through the bottom of the tank, or through an overflow box and siphon. The water trickles through various mechanical and chemical media before falling on some type of matrix supporting the biological filter. There are many types of biomedia in wet/dry filters. Some are silica plates that rock back and forth, alternately exposing the bacteria to nutrient-laden water and oxygen-rich air. Others employ some kind of plastic "bioballs" and have these either showered with trickling water, or actually submersed. The submerged bioballs are less efficient because the bacteria have less oxygen than if they were exposed to the air. Wet/dry filters offer several advantages over some of the other filters we've talked about. First, because the filter sits below the tank, it is out of site - especially if you have the plumbing drilled through the tank. Also, having what amounts to a second tank attached to the display tank effectively increases the volume of water in the system. Greater volume means more stable water chemistry. Finally, in filters that expose the biomedia to the air, the biological filtration in extremely efficient. On the down side, wet/dry filters can be expensive (but you can make do-it-yourself versions). If you want the plumbing through the bottom of the aquarium, this is an additional expense. Also, drilling holes in glass is something that most do-it-yourselfers should not attempt. If you go this route take your tank to a reputable fish store and let them drill it. Overflow boxes and siphons present one significant disadvantage: if the siphon is broken while the pump is on, then the tank can overflow onto the floor! I have read more stories about wet/dry filters causing floods then I care to count. This is not to say that these filters are inherently flood-prone. It just means that one must research all the options and look for possible pit-falls when planning a system with a wet/dry filter. Through-the-tank plumbing pretty much eliminates the possibility of a tank overflow.