Basics of Aquarium Filtration

Leo G. Morin, Ph.D

Fundamental to the success of a healthy aquarium is the stable aquarium environment made possible by scheduled water changes and filtration. Water changes provide systematic removal of wastes not normally removed by filtration and restoration of a balanced ionic environment. No system exists, despite irresponsible or misinformed claims to the contrary, that can replace water changes.

There are five primary types of filter configurations: undergravel, wet-dry, hang-on-the-back, canister, and box. The undergravel filter has limitations, but remains a reliable and simple design. The box filter is inefficient, since water can easily by-pass the filter media. The hang-on-the-back filter is an excellent mechanical filter, but the canister filter is the most efficient chemical filter, and, overall, is probably the best design. The wet-dry filter is basically a gas exchange filter that provides direct loss of ammonia to the air as well as excellent conditions for biological filtration.

There are three types of filtration: mechanical, biological, and chemical. Mechanical filtration is merely the removal of insoluble particulates from the water by some type of sieving device, such as floss or foam. Biological filtration is the removal of ammonia and nitrite waste from water by Nitrosomonas and Nitrobacter bacteria, respectively, and is the most essential of all filtration types. The most reliable aerobic biological filter is the wet-dry. Anaerobic biological filtration converts nitrate to nitrogen. Equipment has also been designed for algae scrubbing where nitrate and organic waste is removed by algae culture. Chemical filtration is the direct removal of solutes by adsorbtion. The most important function of chemical filtration is the removal of nitrogenous organic waste. This is vital, because such waste is both inhibitory to the biological filter and increases the load on the biological filter.

The most familiar chemical adsorbent is activated carbon. Activated carbon should be a little larger than pin-head in size. When washed and dry, it should be dull and not shiny. When placed in water, it should hiss. It should also tend to float at first. Be careful of charcoal, however, because it is dull and floats, but does not hiss. Charcoal is usually very soft, crumbling easily between the fingers and is usually available only in pea-size. Good activated carbon is hard but fragile, feels hard and does not crumble, but fractures under finger pressure. Not all true activated carbons are equivalent. The most commonly available carbons are economical water purification grades, usually derived from wood or nut shells. Coconut carbons are best suited for gas filtration, not water filtration. These are not bad carbons, but you may wish to seek out some better grades. The best carbons are usually produced from bituminous coal and have high porosity and low density. They should also have low ash content to minimize impact on pH. All activated carbons release phosphate, despite claims to the contrary, and only those that release the least should be selected for reef aquaria.

Other types of chemical filtration include synthetic adsorbents, ion exchangers, and zeolite. Zeolites are white, dusty clays, usually sold for removing ammonia from freshwater. Zeolites are ineffective in seawater or even freshwater that contain modest amounts of salt. Zeolites are ineffective for removing nitrates. Synthetic ion exchangers are useful in freshwater to control ionic balance, remove ammonia, nitrite, and nitrate. In marine water, ion exchangers can remove some nitrite and nitrate, but have no significant effect on ammonia. They can also help to retard ionic imbalance. But, generally, the most useful function of ion exchangers, in both fresh and marine water, is organic removal, and in this they excel. Although not an ion exchange process, this ability of ion exchangers to remove organics is phenomenal and works in both marine and freshwater alike.