Rhode Island Sea Grant
FACT SHEET

Water Quality in Land-based Recirculating Aquaculture

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Water quality is a critical component of aquaculture. In the controlled environment of a land-based aquaculture operation, water quality requires particular attention.

In land-based aquaculture, the water system can be either flow-through, in which the water passes through once, or recirculating, in which the water is reused after going through a series of filters. Components in a recirculating system will change with the size of the operation, which may range from large, commercial scale to small research systems. But the basic functions stay the same: physical filtration, biological filtration, sterilization, and water conditioning. Recirculating culture systems allow much greater control of water quality parameters than flow-through systems, but they also require much more monitoring.

Temperature

Temperature is critical to water quality because different species of fish have specific temperature ranges in which they can survive. It is desirable to grow a species in its optimal temperature range for maximum growth, optimal health, and the shortest time to market. Water can be chilled or heated to keep culture temperatures in the optimum range. Recirculating systems require less energy for temperature control than flow-through systems.

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Salinity

Salinity is an important water quality parameter. While some fish species can tolerate wide salinity ranges, many have low salinity tolerance ranges. Yet saltwater fish can be reared inland in recirculating aquaculture systems with the use of artificial seawater or water hauled from the ocean. It is conceivable with these techniques that you could raise flounder in Kansas! Rearing freshwater fish in water with higher than normal salinity helps ward off parasitism and disease.

pH

The acidity of water is indicated by the parts hydrogen (pH). Water that is neutral, neither acidic nor alkaline, has a pH of 7. High pH, above 7, is alkaline; low pH, below 7, is acidic. Most fish grow best at pH levels between 6 and 8, and pH levels of around 7.5 are optimal for bacterial filtration of ammonia in recirculating systems. Oyster shells contain

calcium bicarbonate, which can be used to buffer the water, as can the addition of sodium bicarbonate. Alkalinity is related to pH. High alkalinity levels, greater than 200 parts per million (ppm), increase the stability of pH.

Ammonia

Ammonia is a critical water quality parameter. High ammonia levels are lethal to the fish. Recirculating aquaculture systems must use a chemical process to remove the ammonia. One such process, biofiltration, is carried out by two different species of bacteria: *Nitrosomonas,* which converts un-ionized ammonia to nitrite (which is very toxic to fish) and *Nitrobacter*, which then converts nitrite to nitrate. Nitrate is less toxic to fish and is a nutrient that is taken up by plants. For this reason, some aquaculturists practice hydroponics—growing plants in conjunction with the fish—with their nutrient-rich waste water.

Dissolved oxygen

Dissolved oxygen (DO) is vital for fish survival. Dissolved oxygen is the level of oxygen that is in suspension in the water. Levels greater than 5 ppm are required for respiration. Low levels of DO result in stressful conditions for the fish potentially leading to slowed growth and even death. DO levels can be increased by pumping air (21 percent oxygen or pure oxygen) into the culture tanks.

Suspended solids

Suspended solids can be detrimental to fish health by clogging gills and suffocating the fish. Filtration is necessary in recirculating systems to prevent suspended solid accumulation. Larger particles can be removed by settling or by passing through filters that also remove finer particles.

Pathogens

In recirculating systems, the conditions that favor fish growth also favor bacterial and viral growth. Unless there is some control of the growth of pathogens, fish health will be affected. Biological pathogens can be killed with ultraviolet light, the addition of ozone, or heat filtration.

Conclusion

Good water quality is a key to successful aquaculture. A good water source, careful monitoring, and diligent maintenance can help ensure a successful aquaculture operation.

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