Flow-Through and Recirculatory Water Systems for Fish Tanks

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Summary

A recirculatory aquaculture system is a technology where water is recycled after filtration to remove suspended matter. This method is used for higher density culture of fish, allowing for maximum use of limited land and water. Water movement into and out of the tank maintains peak water quality conditions despite dense stocking rates. As water passes into the tank it provides oxygen and when it leaves it carries away waste products. Intensive aquaculture in tanks that operate at high stocking densities is furnished with a flow-through system that discharges water, cleans water, and pumps it back through the system. Tanks with a conventional flow-through systems are simpler in design but require an affordable and reliable source of quality water that can be used with minimal pre-treatment. Recirculatory systems are more complex and costly to install but have higher water use efficiency, higher feed conversion, and more exact disease control.

Technical Description

For successful fish farming in tanks, the water must have the required oxygen level and temperature for the cultured species. Tank volume and water flow determine the turnover rate, and the required time to replace the entire volume of a unit. Turnover rate is specific to the species being reared and their rearing density, but one turnover per hour is a good place to start for many species. Water passing through tanks simulates a current that can be adjusted by changing the position and direction of water flow. Fish should not struggle against this current, but rather be able to remain stationary with gentle movement. In a recirculatory system, water filtration is continuous, keeping the tank clean and providing a healthier environment for the fish. Waste products are either removed or converted into non-toxic products that can be used for cultivating crops. The purified water is then re-saturated with oxygen and returned to the fish tanks.

Uses

The most suitable location for a flow-through system is where there is reliable water availability from a river or lake, but limited access to electricity. In contrast, the best option for recirculating tanks is near cities with lower-cost and more reliable electricity but where temperatures are sufficiently high to avoid the need of heating.

Composition

Flow-through and recirculatory systems can be fitted to rectangular or circular tanks made of plastic, galvanized steel, or reinforced concrete. For both technologies, water pumps and flow meters are needed, with further sets of filtration and conditioning units for recirculating tanks. A settling pond is usually placed before water reaches the tanks to remove high loads of sediment and algae.

Means of application

Setups of flow-through or recirculatory systems are determined by the water inflow and outflow rates, the tank shape and size, the water depth, the wall roughness, the inlet devices, and the presence of elements inside the tank. Circular tank designs have more stable flow patterns, a more homogeneous distribution of dissolved oxygen and metabolites and better self-cleaning features but are ultimately less space efficient than rectangular tanks. In a flow-through system valves are usually operated manually, and the visible turbidity of water direct the turnover in tanks. In recirculating systems, constant fish respiration can raise carbon dioxide levels high enough to interfere with oxygen levels and lower the pH of the water, thus requiring a buffering system. A series of components can be fitted before the tank inlet to regulate water temperature, oxygenation, and nutrient level.

Agroecologies	All Agroecologies.
Regions	Africa South of Sahara.
Developed in Countries	Zimbabwe, Zambia, Uganda, Tanzania, Sudan, South Sudan, Sierra Leone, Senegal, Rwanda, Nigeria, Malawi, Madagascar, Kenya, Ivory Coast, Ethiopia, Equatorial Guinea, Djibouti, Democratic Republic of the Congo, Cameroon, Burundi, Botswana, Benin.
Available in	Zimbabwe, Zambia, Uganda, Tanzania, Sudan, South Sudan, Sierra Leone, Senegal, Rwanda, Nigeria, Malawi, Madagascar, Kenya, Ivory Coast, Ethiopia, Equatorial Guinea, Djibouti, Democratic Republic of the Congo, Cameroon, Burundi, Botswana, Benin.
Solution Forms	Equipment.
Solution Applications	Fish Farming.

Agricultural Commodities	Fish.
Target Beneficiaries	Small-scale farmers, Commercial farmers.

Commercialization

Commercialization Category

Commercially available

Startup Requirements

Equipment to build and operate flow-through and recirculatory systems for fish tanks is marketed by suppliers in most fish farming areas across Sub-Saharan Africa. The main steps toward adopting the technology are: 1) Choose the most suitable water management for tanks based on farm setting and investment needs, 2) Acquire skills to install and operate the equipment under optimal conditions, and 3) Test the water quality at the point of source and discharge to establish pre- and post-treatment needs.

Production Costs

A flow-through tank with a fixed volume of 200 liter requires 800 liter of water per hour, equivalent to a turnover rate of four. For a tank of 130 m3 the approximate cost of the recirculation pumping and piping is US $22,000 and the mechanical, physical, biological and chemical treatment is US $44,000. Costs of water supply and treatment are hugely influenced by the position and type of drainage. The charges of contractors to build a settling pond are US $1.5 to $5 per square meter for different soil types and lining materials.

Customer Segmentation

Flow-through systems are feasible for small-scale fish farmers that can access waterbodies and have rights to their waters. Recirculatory systems best serve commercial fish farmers owing to higher equipment and maintenance costs.

Potential Profitability

The improvements in controlling water quality by flow-through and recirculatory systems directly reduce mortality rates, disease control, and feed inputs. In Nigeria, grow-out tanks for tilapia with a flow-through system have been found to break even on fixed and variable costs in the first production cycle, with incremental profits in subsequent cycles. Recirculatory systems need to be implemented at a large scale and with high value freshwater fish such as trout or Nile tilapia to offset capital costs and be financially sustainable.

Licensing Requirements

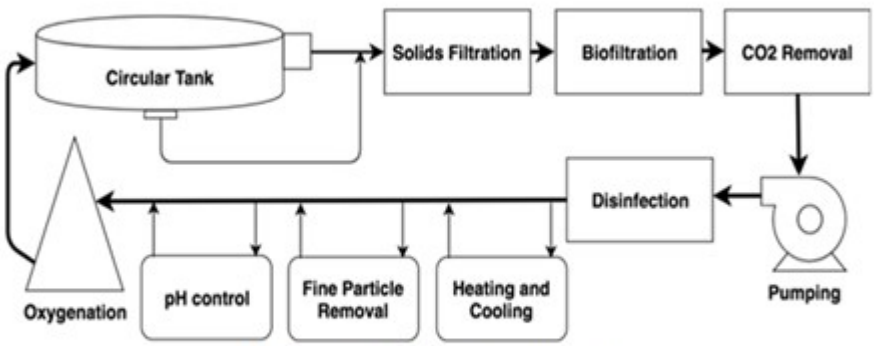
Sophisticated recirculatory water filtration systems require commercially available equipment that is protected by patents.

Innovation as Public Good

Information on these systems is a Regional Public Good advanced by WorldFish.

Solution Images

Flow-through tanks with single use of water



Schematic diagram of a recirculatory system

Institutions

Accompanying Solutions

All Male Tilapia Fingerlings with Greater Yield and Uniformity

Fast Growing and Hybrid African Catfish