Recirculation Systems

The global increase in aquaculture production over the last two decades has led to increased research into production methods which demonstrate greater independance from the influence of external factors. Recirculation systems are land based systems used in aquaculture to conserve water and monitor/contol the various inputs and waste products of the fish farm. These systems can be categorised into 3 types (flow-through, partial recirculation or full recirculation systems) depending on how much water is recirculated in the system. The increased understanding of biological processes and improvements in technology, have resulted in recirculation systems becoming a viable alternative to open culture systems.

Recirculation systems are currently utilised across a wide range of species in many stages of rearing including broodstock holding, hatchery/nursery rearing, grow out and as quarantine units. Species currently cultured having life cycle stages in recirculation systems include turbot, halibut, cod, perch, eel, catfish, tilapia, seabass and sea bream. The increase in use of recirculation systems from hatchery to harvesting phases stems from the ability to set consistent optimal conditions for growth, prevent infection from external pathogens, and to trace all inputs into the cultured stock.

Seahorses

Seahorse cultivation requires stringent water quality. Recirculation technology ensures a stable environment for the seahorses with optimum conditions resulting in improved growth and survival rates.

Abalone

Studies in the UK and Ireland have clearly indicated that there is potential for farming European abalone in recirculation systems.

Turbot

Turbot is an established species in recirculation aquaculture where it is possible to rear from hatchery to harvest stage. Turbot can reach market size in approximately 18 to 24 months in optimal conditions.

Cod

Cod is a relatively new aquaculture species. Hatchery trials are currently underway in Ireland and the UK where cod are grown in a recirculation system prior to being transferred to sea cages for ongrowing.

ADVANTAGES OF RECIRCULATION SYSTEMS

CONTROLLED ENVIRONMENTAL PARAMETERS

Recirclation systems allow increased control over temperature, dissolved oxygen, photoperiod, and water clarity. With full control over water parameters, the stocking densities of the stock can be increased, allowing greater economies of scale. Growth rates are often much better in recirculation systems compared to other ongrowing methods.

STOCK ISOLATION

By ensuring that cultured stock cannot escape and breed with wild stocks, a major environmental concern is eliminated. It is believed that breeding between cultued and wild stocks could adversely affect the gene pool of wild stock through the inheritance of genes that may not optimally ensure survival in the wild.

MINIMISATION OF WATER USAGE

The use of recirculation systems as opposed to flow through systems greatly reduces total water used per weight production, from several m3 in common flow-through systems to less than 100 litres per kg of feed in efficient recirculating systems.

INPUT TRACEABILITY

The controlled conditions under which a recirculation system operates means it is possible to have a superior quality assurance system in place by means of monitoring all inputs to the system.

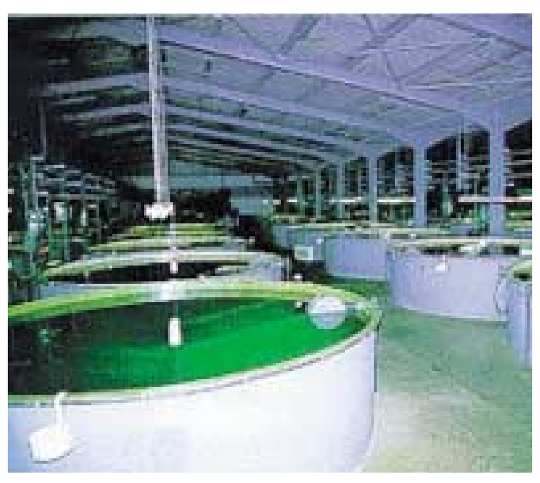
REDUCED EFFLUENT

Recirculation systems have little or no effect on the "downstream" environment. Control is achieved by separating faecal material and uneaten feed from the waterflow, and other metabolic waste is removed using advanced filtration mechanisms. Any waste is collected in the form of a concentrated sludge which can be disposed of in an environmentally friendly manner.

MARKET ACCESS

Recirculation systems require very little water and emit effluents in the form of a concentrated sludge. This means locating near major water source is not necessary and thus it is possible to locate a farm near the target markets lowering transport costs and providing a fresher product.

FEATURES OF A COMPACT FULL RECIRCULATION SYSTEM

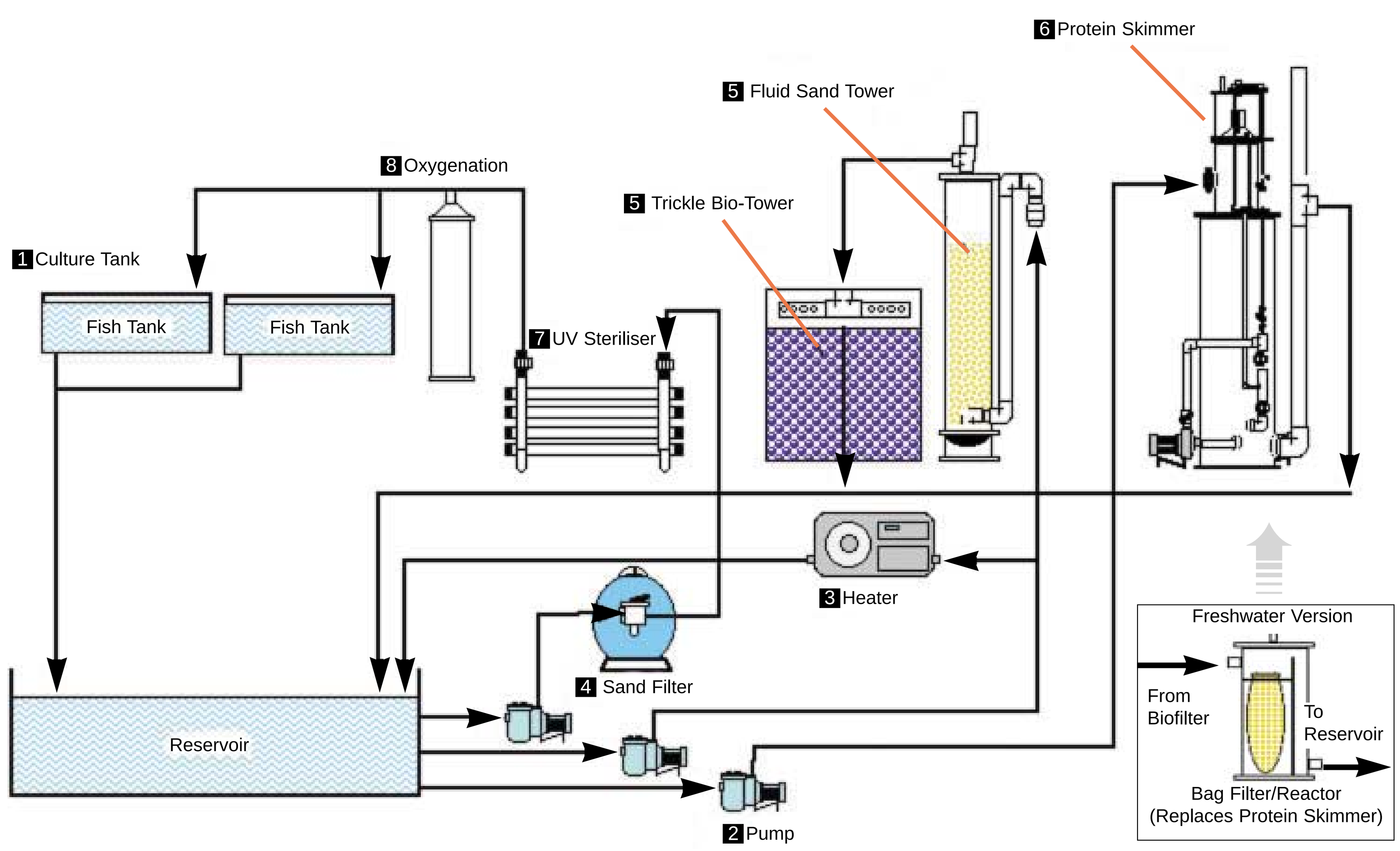


1 Culture Tank

Most culture tanks in recirculation systems are made of circular fibreglass. These tanks are designed to minimize the water residence time in the tank and maximize the feed and waste removal. Some water exits the bottom of the tank, taking with it the bulk of the waste particles in the form of sludge. The bulk of the water however leaves to be treated in the system below.

8 Oxygenation

In intensive production systems, the rate of oxygen consumption by fish and bacteria may exceed the capabilities of typical aeration equipment. In order to maintain a high carrying capacity, pure gaseous oxygen injection is used to allow a higher availability of Oxygen



2 Pump

All recirculation systems require a pump or other water movement devices to distribute water through the system. To function efficiently and reliably, pumps must be carefully selected and integrated into the system. The two main types of pumps found in aquaculture systems are centrifugal impeller and axial flow pumps.

7 UV Sterilisation

Disinfection of recirculated water is achieved through ultraviolet (UV) irradiation. When water is passed through the UV steriliser above, microorganisms in the water come into contact with UV radiation emitted into the channels. The UV radiation penetrates the cell membranes, either destroying or debilitating any micro-organisms present.

3 Heater

Maintaining the optimal temperature range is critical to healthy growing conditions. In the system shown a titanium heater is used to control the temperature. Operational temperatures vary depending on the species grown. In some cases a chiller may be needed rather than a heater.

4 Mechanical Filtration

Continuous and effective removal of particulate waste can be achieved by a variety of mechanical filtration methods. The use of sedimentation tanks is the oldest and simplest method for suspended solids removal. However the use of microscreen filters in drum and disc filters is common on large systems whilst sand filters are more common on smaller systems. More advanced systems use granular media filters (sand, gravel or plastic media) to capture solids and to provide a substrate where biofiltration can occur. Thus granular media filters can function as both mechanical and biological filters. Combining both mechanical and biological filtration has the added benefit of waste concentration, reducing the water volume that must be expelled with the solids and assisting the eventual treatment or disposal of sludge produced. Pictured left is an example of a pressurised sand filter.

5 Biological Filtration

Biological filtration uses live microorganisms to neutralise or remove unwanted substances from the recirculation water. Ammonia the waste metabolite from protein digestion and Nitrite are toxic to fish. The removal of Ammonia by oxidation to Nitrite and finally Nitrate is carried out by the bacteria species Nitrosomonas and Nitrobacter respectively in a process called Nitrification. The resultant nitrate is non toxic to fish even at high concentrations. Biological filters consist of media with a large surface area where culture bacteria can grow. As water passes through, bacteria utilise the waste products for their own metabolic processes. The effectiveness of this process depends on the amount of bacteria that can be grown and maintained optimally. Biological filtration can be carried out in a variety of units including trickle towers, gas/bio towers, fluidised sand bed filters or combinations such as bio sand filters.

6 Protein Skimmer

Proteins are extracted from the water column by vigorously mixing the water with injected air or liquid oxygen. The foam produced from this process then floats on the surface of the water and can be "skimmed". This process also aerates the water at the same time. Additional use of ozone cracks up any remaining organic material that could adversely influence the development of fish. Protein skimmers are most effective in saltwater. Freshwater systems utilise a bag filter/reactor system.

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AquaTT, P.O. Box 8989, Dublin 2, Ireland.
Tel: +353 1 644 9008, Fax: +353 1 644 9009, E-mail: aquatt@aquatt.ie

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