Recirculating Aquaculture System (RAS) for Finfish Breeding

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Essential components of a hatchery include Seawater intake, filtration and storage, Recirculatory Aquaculture System (RAS) and larval and fingerling rearing tank

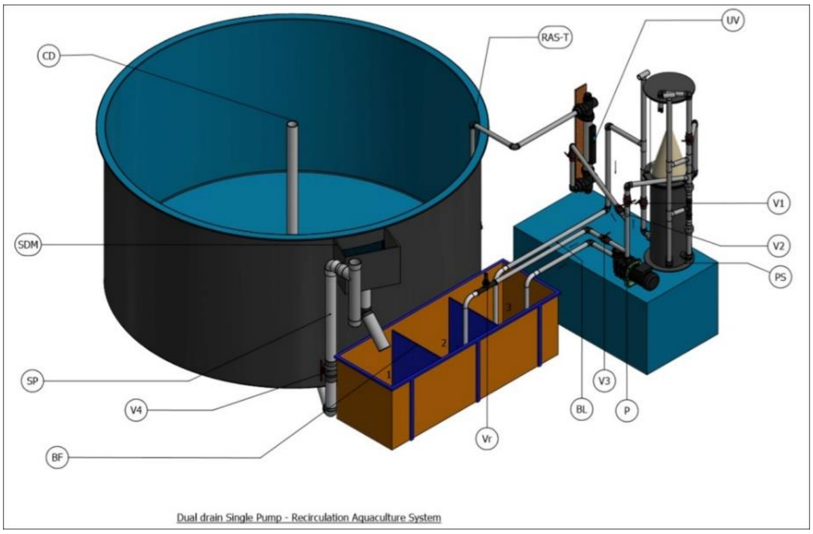
Seawater intake, filtration and storage

Proximity to unpolluted seawater sources is crucial for the success of a hatchery. The area must be free of domestic and industrial pollution, and a stable salinity will ensure the year-round functioning of the hatchery. Seawater for hatchery can be pumped from surf water or a bore dug near shore. Water from the bore is preferred as it would avoid many organisms entering the seawater system, as the sand over the suction provides a primary filtration at the intake point. The seawater collected from surf water can be pumped through a pressure sand filter to remove suspended particles. Pumped water is settled in a 50 t concrete tank and chlorinated before use (60 g TCC chlorine/30 tons of seawater) and kept overnight with aeration. Dechlorinated water was then pumped to the storage (Overhead tank) of a 50-ton capacity storage tank made of either concrete or fiberglass. Seawater from the overhead tank is passed through a cartridge filter and UV before transferring it to the LRT tank. Cartridge filters and filter bags used in the hatcheries must be washed with chlorine water after everyday use, and water needs to be checked for chlorine level to ensure that it is free from residual chlorine.

Recirculating Aquaculture System (RAS)

Maturation of most coastal fishes may well be achieved if the animals are maintained in good quality seawater, provided they are well fed and reared without the stress of overcrowding and disturbances. RAS provides the perfect opportunity to manipulate environmental conditions that are critical in maturation processes, such as temperature, photoperiod, nutrition and other water quality parameters in addition to facilitating observation of the behaviour of fishes and do various husbandry steps. There is a need for the development of cost-effective, economically viable systems that minimize the environmental impact while at the same time ensuring optimal rearing conditions. Present article describes design and operation of low-cost RAS systems developed and perfected at Vizhinjam Research Centre of CMFRI for broodstock development of marine fishes, which include 30000 to 2000 l FRP systems with mechanical, biological filtration subsystems including disinfection, temperature control and photoperiod manipulation, using equipment such as, proteins skimmer, UV filters, chillers, biological filter cabinets and LED lighting with timer control.

A typical 10 t system is described here (Fig.) and it is a dual-drain recirculatory aquaculture system (RAS). RAS tank had a central drain (CD) of 4-inch diameter depending on the capacity of the broodstock tank and a side overflow (overflow drain-OD) opening made by cutting off a strip of 20 cm length and 5 cm height from the sidewall of the tank. This opening was protected with a 3 mm mesh screen to prevent brood fishes from escaping. The water flowing out from the side drain of the tank falls into a box-shaped chamber and further into a 4-inch diameter tube or conduit fixed to the bottom plank of the box, which also facilitated the collection of floating eggs for incubation and hatching. A 3-inch diameter standpipe (of length more than 4 cm of the required water depth in the tank) was fixed in the central drain hole inside the tank which had holes drilled on its lower one-foot length, to selectively remove waste from the bottom of the tank or this stand pipe can be totally replaced with a filter grid or end cap with holes drilled for passage of collected waste because of the swirl settling effect. The central drain was connected to the standpipe (SP) fixed outside the tank close to the side drain via a 3inch diameter pipe running underneath the tanks using a 3-inch elbow. This standpipe has a height slightly lower than that of side drain level (which is essential for regulating the percentage flow via overflow/central drain) and was provided with a valve (V4) to regulate the water flowing out through the central drain. This helped to direct the full outflow through the central drain when the valve was kept fully open. Thus, by regulating the water flowing through the standpipe valve (V4), the percentage of water that goes out through the central drain and side drain could be controlled. Water (depth) in the tank will remain at the side overflow level if water is allowed to flow out through both the outlets. It is maintained at 1.0 m depth and the recirculation flow rate in the RAS was maintained at 9000 l h^{-1} in the case of 10 t system.



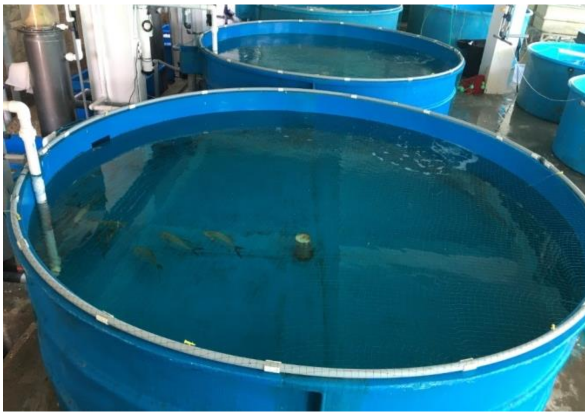
RAS-T – tank;
CD-central drain;
SP-standpipe with valve;
OD- overflow drain;
BF-biological filter;
P-pump;
PS-protein skimmer;
BL-bypass line;
UV-F- Ultraviolet filtration unit;
V-valve, Vr-venturi.

Dual-drain single pump recirculation aquaculture system (RAS)

The outflow from the tank, drained through the central drain and side drain fell into (the first compartment) a bio-filtration system (BF) of size 180 x 70 x 60cm with three compartments, with partitions facilitating the flow of water from one compartment to the other serially. The first compartment was packed with a sponge filter, bio-balls, and coral rubbles in such a way that incoming water gets first filtered by the sponge (If required an additional filter bag or filter box with overflow can be kept at the outlet of central drain to collect the solid waste). Filter sponge has to be cleaned with seawater twice a week. The next two compartments are packed with moving bed biofilm reactor (MBBR) media which was aerated and kept fluidised for efficient bio-filtration. Foot valve of the suction pipe of the pump (P) is kept in the last chamber (3^{rd}) which pumped water out of the biological filter. The delivery was divided into three pipelines and seawater to each was controlled by three valves namely V1, V2 and V3. The valve V1 delivered water to a protein skimmer (PS) with a capacity of 250 l $min^{-1}$and from the protein skimmer (PS) skimmed-aerated seawater was pumped back into the third chamber of the biological filter through outflow line of the skimmer. This kept the MBBR media in the third chamber in suspension. Valve V2 regulated the water flow into the RAS tank via UV system (Emaux Nano Tech Series UV System with timer - maximum flow rate of 15 m^3 per hr). Aeration is provided in the second chamber of biological filter by a venturi (Vr) connected in the bypass line (BL-the third branching line from the delivery line of the pump) and water flow was controlled by valve V3. This line brought the remaining water and air sucked in by the venturi into the second chamber and delivered the same below the MBBR media filled in the chamber through a bubble maker grid/disc. High-density systems of more than 30 t may require a drum filter for physical removal of particles before the water passed into the biological filter. Physico-chemical parameters such as salinity, pH, dissolved oxygen, water temperature, NH3-N of the seawater in the system has to be checked at regular intervals.

An average flow rate of 30 t, 10 t and 5 t RAS was 15000 lit/hour, 7000-9000 litre/hour and 1500-2000 litre/hour respectively. Normally 12 h L:12 h D photoperiod was maintained during the culture period but 14 h L:10 h D is useful to speed up the oocyte maturation and light intensity of more than 2000 lux has to be provided. Temperature control if needed could be achieved by passing the seawater through a chiller-heater combination taking a bypass line from the main delivery line and releasing back in the second or third compartment of the filter. These systems were successfully used in the maturation and spawning of serranid fish Marcia's anthias *Pseudanthias marcia*, Pink ear emperor *Lethrinus lentjan*, Silver pompano *Trachinotus blochii* and Banded grunter *Pomadasys furcatus* in the finfish hatchery of Vizhinjam Research Centre of ICAR-CMFRI. Adult sized fishes (*L. lentjan*) usually takes 4-6 months on an average to start volitional spawning and 6-12 months for *T. blochii* to reach oocyte maturity (500 to 600 µ) required for hormone induced spawning.

RAS 30 t Brood fish rearing tanks



RAS Breeding tanks with dual drain system for egg collection

Uniqueness of this new system include; it's simple design, operates with single pump, regulation of percentage outflow through overflow and central drain by a single valve, aeration and stripping of CO_2 achieved by venturi and low coast.

Larval and fingerling rearing tank

Different types of tanks are used for larval rearing; the usual sizes are 2 and 5 t tanks. Specially designed RAS systems can be used for larval rearing in high densities. Fiberglass or polypropylene tanks are commonly used for larval rearing.

D-Shaped RAS Fingerling production system

D-shaped or circular flow-through or recirculating aquaculture systems are used for fingerling production. RAS is found to be most suitable for fingerling production.