Brief Communications

Design of low-cost indigenous recirculating aquaculture systems (RAS) for broodstock maturation of marine fishes

M. K. Anil*, P. Gomathi, Ambarish P Gop, S. Surya, B. Raju and A. Udayakumar
Vizhinjam Research Centre of ICAR-Central Marine Fisheries Research Institute, Vizhinjam P.O., Thiruvananthapuram-695 521, Kerala

* E-mail: mkanil65@gmail.com

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 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 by ICAR-CMFRI for broodstock development of marine fishes, which include 30000 to 2000 l FRP systems with mechanical, biological filtration sub systems 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 with a dual-drain recirculatory aquaculture system (RAS) is described here (Fig. 1). RAS tank has a central drain (CD) of 4-inch diameter depending on the capacity of the broodstock tank and a side overflow opening (overflow

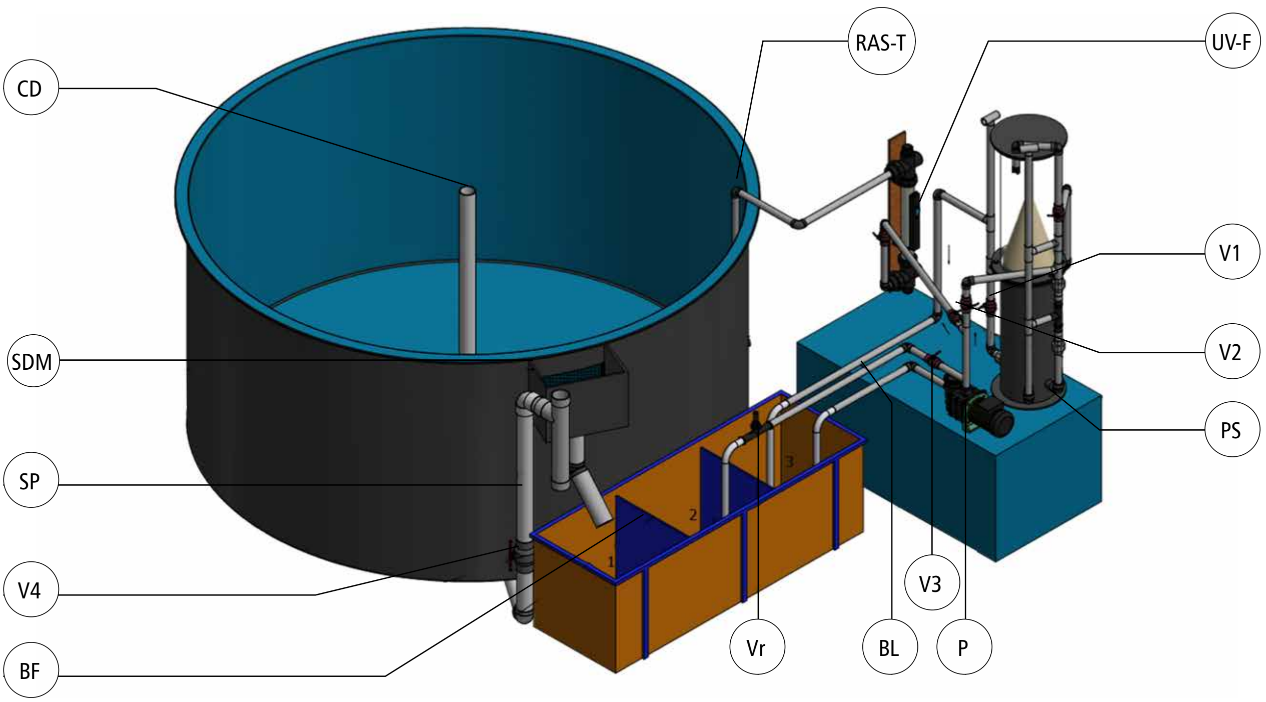

Fig. 1. Dual-drain single pump recirculation aquaculture system (RAS)
RAS-T-tank; CD-central drain; SP-standpipe with valve; OD- overflow drain; BF-biological filter; P-pump; PS-protein skimmer; BL-bypass line; UV-F- Ultraviolet filtration unit; V-valve, Vr- venturi, SDM- side drain mesh

drain-OD) made by cutting off a strip of 20 cm length and 5 cm height from the sidewall of the tank. This opening is 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 facilitates 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) is fixed in the central drain hole inside the tank which has holes drilled on its lower one-foot length, to selectively remove waste from the bottom of the tank. The central drain is 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 is 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. It is maintained at 1.0 m depth with the recirculation flow rate in the RAS at 9000 l h^{-1} in the case of the 10 t system.

Filtration system

The outflow from the tank, drained through the central drain and side drain fell into 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. 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 is aerated and kept fluidised for efficient bio-filtration. Foot valve of the suction pipe of the pump (P) is kept in the last chamber (3rd) which pumps 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 there the 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.

Fig. 2. RAS tanks in operation at marine fish hatchery of Vizhinjam Research Centre

An average flow rate of 30 t, 10 t and 5 t RAS was 15000, 7000-9000 and 1500-2000 litre/hour respectively. Normally 12 h L:12 h D photoperiod is maintained during the culture period but 14 h L:10 h D speeds up the oocyte maturation and light intensity of more than 2000 lux also has to be provided. Temperature control, if needed, is 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 while *T. blochii* requires 6-12 months to reach the oocyte maturity (500 to 600 μ) stage when hormone induced spawning can be done.