Recirculating Aquaculture system (RAS), Biofloc technology (BFT) and Aquaponic system: an Overview

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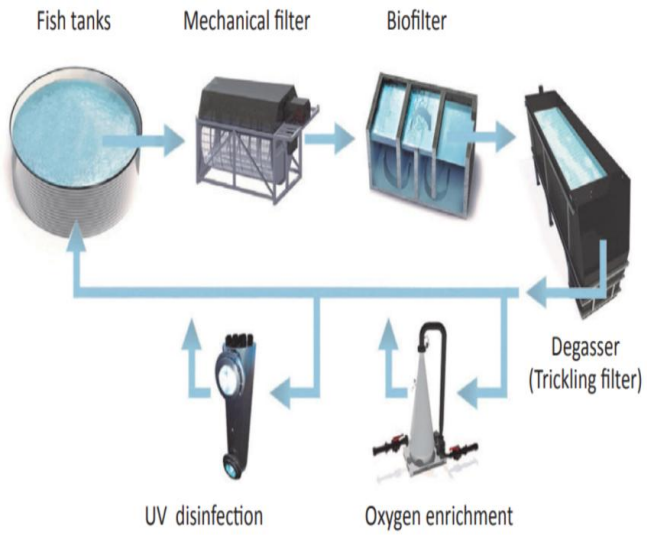
Recirculating aquaculture system is a technologically advanced system for farming fish or other aquatic organisms that involves reusing the water in the production with less than 10% of total water volume replaced daily. The technology can be utilised for any species grown in aquaculture by employing mechanical and biological filters. However, to compensate for high operating expenses, it is typically used to cultivate high-value species (barramundi, catfish, eels, perch, prawns, salmon, seabass, seabream, prawns, sturgeon, trout and tuna) with high stocking densities and year-round production.

Working principle

The basic principle of recirculation is that the water flows from the outlet of the fish tanks to a mechanical filter, then to a biological filter before being aerated and free of carbon dioxide and then returned to the fish tank. Some additional water treatment components, such as oxygenation with pure oxygen, ultraviolet or ozone disinfection, automatic pH management etc., can be incorporated, depending on the needs, to enhance the water quality and control the occurrence of any disease inside the system.

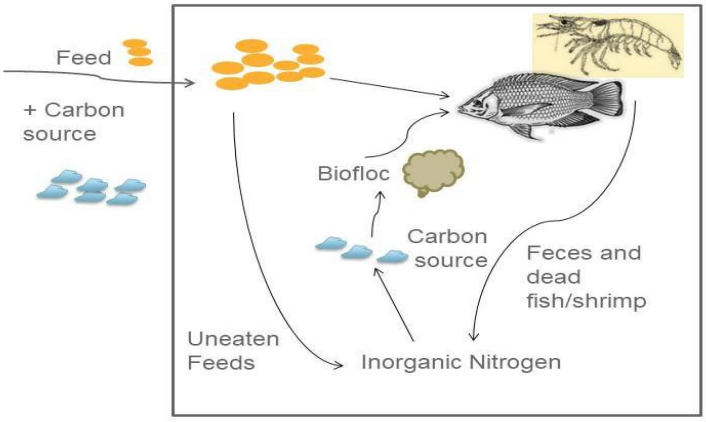
Biofloc technology

Biofloc technology (BFT) is based on maintaining high levels of microbial bacterial floc in suspension, maintaining constant aeration and adding a suitable carbon source to allow aerobic decomposition of the organic material. Manipulation



of the C/N ratio converts toxic nitrogenous wastes into beneficial microbial protein and helps improve water quality under a zero-water exchange system. For optimum growth of bacterial population for ammonia and nitrite assimilation, there is a need to maintain a C: N ratio of the culture unit between10:1-20:1.

Fish species that can tolerate high solid concentrations are omnivores in feeding, tolerant to poor water quality, and fluctuations of ammonia are



best suited for bio floc systems. The production of shrimps, tilapia, and carp that consume the flocs directly has realised most of the advantages of biofloc technology.

Working principle

An initial microbial inoculum is prepared following the standard protocol, and the inoculum is added to the tanks after 24 hrs of incubation. The system is kept well aerated before the introduction of fish stocked after forming optimum floc volume. Zero or limited water exchange is done. Feed is provided to the fish at @2-3 % of their body weight, and a carbon source is added to the tank. The tank is maintained with vigorous aeration and mixing so that ideal conditions are created for the growth of microbes. Microbial population assimilate harmful nitrogenous compounds like ammonia excreted by fish for their growth and are converted into microbial proteins on which fish feeds.

Aquaponic system

Aquaponics is a bio-integrated production that combines recirculating aquaculture with hydroponics to produce fish and plants in a closed-loop system that resembles nature's ecosystem.

Working principle

Fish are raised in a tank, and the water from the fish-rearing tank passes through the filters (both mechanical and biological filters), which remove the fish's solid wastes (mechanical filtration) and the dissolved toxic wastes like ammonia is converted to nitrates (biological filtration) that are accessible for plants. Once this nutrient-rich water passes through the plant beds, plants uptake the nutrients, and the filtered water is returned to the fish tank. Aquaponics provides a sustainable means of production, especially in areas where the land and water resources are limited by using cost-effective and non-chemical nutrient sources and the reuse of filtered water.

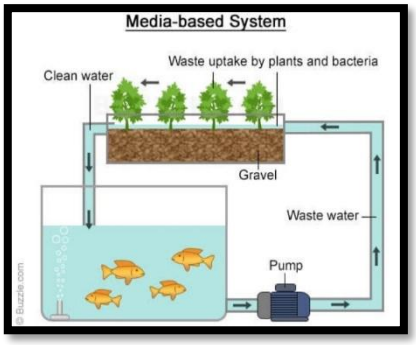
Different types of aquaponic systems

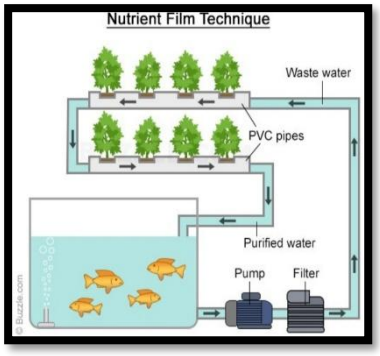
Media Filled beds

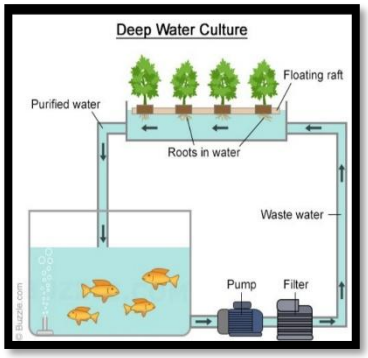
Plants are grown in a container filled with media (expanded clay pebbles, gravel, perlite). Water from fish tanks may not require mechanical filtration because the solid material is broken down while passing through the media. Moreover, the media provides a large surface area for the growth of beneficial nitrifying bacteria. This is the most straightforward technique and requires comparatively fewer components. The method can be used for small-scale aquaponics.

Nutrient Film Technique

In NFT, nutrient-rich water from fish tanks passes through horizontal PVC pipes with small cups or holes for holding plants. The plant roots are in direct contact with nutrient-rich water flowing through pipes and absorb the same. This technique is suitable for leafy green vegetables with small







roots. Plants with large invasive roots will hinder the water flow and clog the pipes. This technique needs biofilter because the system's surface area is not much exposed to air.

Deep Water Culture or Raft system

Plants are grown on the rafts (foam or polystyrene) floating on the water surface. The plants can be erected within the holes directly, or net pots filled with media can be placed in the pits for additional support on the raft and the roots remain dangling in the water column. Extra aeration is needed under rafts because the seeds remain submerged in water. Rafts can be placed directly over the fish tank, or a separate raft tank can be used, the latter being used most often. This technique is most promising, production efficient, and used mainly for large-scale operations.

Table 1: Plant and Fish species used for aquaponics

Vegetables	Fruits	Flowers	Herbs	Fish species
Lettuce, beans, squash, zucchini, broccoli, pepper, cucumber, carrot, onion, reddish etc.	Strawberries, watermelon, cantaloupe, tomatoes etc.	Most garden varieties	Basil, thyme, cilantro, Lemongrass, oregano etc.	Tilapia, trout, Bluegill, carp, freshwater prawns, aquarium fishes like goldfish, tetra cichlids, guppies, Oscar etc.

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