1. Introduction

A Re-circulation/Flow-through system is an enclosed system for fish farming where the water replacement is only to the extent of loss to evaporation and cleaning. In Re-circulation System water is reused or partially exchanged, while a production system that uses water only once is referred exclusively as a Flow-through system.

It is an intensive approach (higher densities and more rigorous management) than other aquaculture production systems. Instead of the traditional method of growing fish outdoors in open ponds and raceways, this system rears fish in indoor tanks within a "controlled" environment. Re-circulating systems filter and clean the water for recycling back through fish culture tanks. The technology is based on the use of mechanical and biological filters, and the method can be in principle, used for any species grown in aquaculture. New water is added to the tanks only to make up for splash out, evaporation and for that used to flush out waste materials. The reconditioned water circulates through the system and not more than 10% of the total water volume of the system is replaced daily. In order to compete economically and efficient use of the substantial capital investment in the re-circulation system, the fish farmer needs to grow as much fish as possible in the inbuilt capacity.

Given the fact that traditional methods of fish farming in India is able to produce upto 2-10 MT of fish per hectare of land and at the same time uses more than 20 litres of water per kg of fish. Contrary to this, Re-circulatory Aquaculture System may need 1/8th of a hectare & 1/6th of water and still would be able to produce up to 60 MT of fish per year.

2. Advantages of RAS

Re-circulation/Flow-through systems in aquaculture have stirred a great deal of interest in the field of fish farming and expanding very fast globally. There are several advantages in establishing Re-circulation/Flow-through culture systems.

- The flexibility to choose the scale and module is the greatest advantage of this culture system, where the entrepreneur has the ability to measure and control most of the production and marketing related variables.
- Wide range of design and site as per geo-climatic conditions and investment capabilities. It can be used in extreme weather zone also with ease.
- Very low requirement of land and water as compared to pond aquaculture system.
- Independence from a land based large water source.
- Reduction in wastewater effluent volume and ability to closely monitor and control environmental conditions to maximize production efficiency.
- Increased bio-security and ease in treating disease outbreaks if any.
- High output fish from minimal area with fish density ranging up to 50-150kg/m3 under perfect conditions.

3. Constraints

- High upfront investment in materials and infrastructure.
- Intensive technical monitoring of operations.
- Assured but limited supply of energy for operations.

4. Indian Scenario

Our country ranks good on fresh water fish production as traditional methods of fish farming in India are able to produce just between 2-10 MT of fish per hectare of land while Re-circulating Aquaculture System may produce up to 500 MT of fish per year in same area. There is deficit of proper knowledge, expertise in technical management of Re-circulatory systems and entrepreneurial attitude for commercial scale units. The high investment costs may have kept RAS away from our country until now. But there is an amazing potential for it in India and with growing interest the units are coming up in Uttar Pradesh, Andhra Pradesh and elsewhere. In the next 5 years, these are going to be seen in many places in India for sure and RAS would be the next big thing in Inland Fisheries sector to happen in coming years.

11. FARMING IN RE-CIRCULATORY AQUACULTURE SYSTEM

About the Farmed Fishes

Pangasius and Tilapia both are ideally suited for culture in RAS. Presently emphasis is more over the Pangasius due to different reasons. Pangasius belongs to a full family of catfish living in the Mekong and its estuaries in Vietnam. It is commonly called as river or silver stripped catfish, Siamese shark, sutchi catfish, or swai catfish. This fish species live in freshwater. It exhibits fast growth when cultured given a good environment. Two members of this family can be farmed - the *Pangasius hypophthalmus* (Vietnamese: Tra) and the *Pangasius bocourti* (Vietnamese: Basa). It is cultured due to its strong market demand and fast growth; few countries dominate the culture production. Being the 3rd most important freshwater fish group within aquaculture sector, Pangasius is now cultured in several countries in the world like Thailand, Nepal, Pakistan, India, Bangladesh, Vietnam, Laos, Myanmar, Indonesia, and Cambodia. *Pangasius hypophthalmus* contributes more than 90% in global culture output. **Pangasius** is an air-breathing fish that can tolerate low Dissolve Oxygen (DO) of the water. It can be cultured in fish ponds, concrete tanks, fish cages or fish pens.

11.1. Culture Protocol

1. Efficient source of water.
2. Free from pollution and acute environmental variations

3. Free from poachers or any social disturbance

4. Assured source of power/electricity

5. Fill the pond with water to about 1.5m to 2m deep, to provide a wide environment for the stocks.

6. *Pangasius* spp. can be stocked at a rate of 3-15 pcs/m2 depending on the culture environment. Stocking should be done early morning or late afternoon. Survival rate of *Pangasius spp.* is estimated to be 80-90%.

7. Pangasius is omnivorous (eat both plants and animals) during their first year and become herbivorous for the following years. Pangasius can be fed with pelleted feeds (recommended for faster growth and better fish quality) at a rate of 2.5% of their average body weight (ABW) and will be adjusted bi-weekly. Feed Conversion Ratio (FCR) averages to 1.5:1, which makes it suitable for culture.

8. Water is important for all fish, so optimum conditions for certain parameters of water should be the primary factor to consider in engaging to fish culture. Water quality parameters like pH (6.5 - 7.5), Dissolve Oxygen (DO) (0.1 mg/l), Temperature (25 - 30° C), Salinity (< 2 ppt) and water depth (1.5 - 2m). These should be maintained to get a better yield for the culture of *Pangasius spp.*

9. Sampling is done to monitor the growth of stocks and to compute feeds to be given to the stocks for the subsequent days. This is also done to see if the stock reaches its marketable/harvestable size. Since *Pangasius spp.* is fast grower fish, sampling is mandatory.

10. Harvesting can be done in partial (selective harvesting) or total harvesting. *Pangasius spp.* can be harvested for about 4-6 months of culture period. It can reach the weight of 1-1.5 kilogram in 6 months of culture, of managed properly.

11.2. System Design

Re-circulation/Flow-through systems are beneficial where only limited water is used for removal of fish wastes out of the production system. Passing water through a treatment unit removes ammonia and other waste products, the same

effect as a Flow-through configuration is achieved. A key to successful re-circulation production systems is the use of cost effective water treatment unit to remove solid wastes, oxidize ammonia and nitrite-nitrogen. The above following issues must be addressed fully for successful re-circulation systems in aquaculture.

11.3. Fish Farming Re-circulation/Flow through System

The present re-circulation system is designed to handle more than 100 table fish/m^3. Each tank measuring 7.65x7.65x1.5 m dimensions having water capacity of 81.93 m^3 Eight tanks of any configuration or culture tanks. The waste treatment system, Bio-filter and other support components are taken into account as described in previous sections and shown schematically in figure.

11.4. Over All System Layout and Components of RAS Unit.

The major work entailed in proposed system is construction of cemented culture tanks, and fabrication of pipe lines, power availability and water treatment facilities. The design and construction details for the project are mentioned in relevant sections.

11.4.1. Fish Culture Tanks

A unit of total 8 tanks is proposed with the dimension of 7.65 x 7.65 x 1.5 m for each tank. The building material needed is bricks, cement, sand *etc* which are locally available. Flow of water out of tanks completes under the gravity.

11.4.2. Water Source

A bore well with a capacity of 3'' delivery is the main source of water supply. Power supply to run bore well may be electricity or pump set.

11.4.3. Water Delivery and Hydraulic Gradients

Water will be channelled to each pond through delivery lines. Water flows from culture tanks to treatment plant or discard drain under gravity The top of

treatment basin or out-flow channel remain lower than bottom of culture tanks. All right angle turns are made with 'tee' fittings to ease cleaning. PVC pipes and superior quality accessories will be used in all water lines to ensure adequate strength of the system.

11.4.4. Temperature Control System

The ambient temperatures of water vary with the species characteristics being cultured. It is achieved by construction of poly-house to create *greenhouse* effect or by supplement of underground water.

11.4.5. Aeration System

Aeration may be provided through stone diffusers located at bottom in each tank. Air is supplied from pump mounted above water level. The air delivery line is 1 inch diameter PVC pipe and fitted with ¼ inch diameter flexible tube connecting the PVC pipe with air delivery system of air-stone diffusers.

11.4.6. Filtration System

Managing a bio-filter is related to all of the water quality tests, any of which tells what filter needs and how well it is doing. The goal is to make bio-filter function as efficiently and as stable as possible, while the practice of growing fish, increasing feed, harvesting fish and adding material to the water reduces efficiency and makes the filter less stable. A healthy bio-filter has a very thin growth of orange-brown coloured bacteria on the surface of the bio-filter material. Thick clumps of a brown slimy material is likely to be heterotrophic bacteria and not nitrifying bacteria, these may lead to clogging of the filter and also pipes and should be discouraged by keeping the particles of uneaten feed and wastes out of system as much as possible. Water quality tests must be looked at in two ways. What does it mean to my cultured species and what does it mean to bio-filter?

11.4.7. Design Parameters

1. Production capacity: 42.70 MT
2. Capacity of each culture tank: 81.93 cum
3. Total number of Tanks: 8
4. Total capacity of all tanks: 655.44 cum

11.4.8. Project Cost:

1. Total Capital Cost: ₹ 30, 84, 648/=
2. Total Operational Cost: ₹ 1918000/=

Total: **₹50, 02,648** [say Rs.50 00 000/= (Fifty lakh only)]

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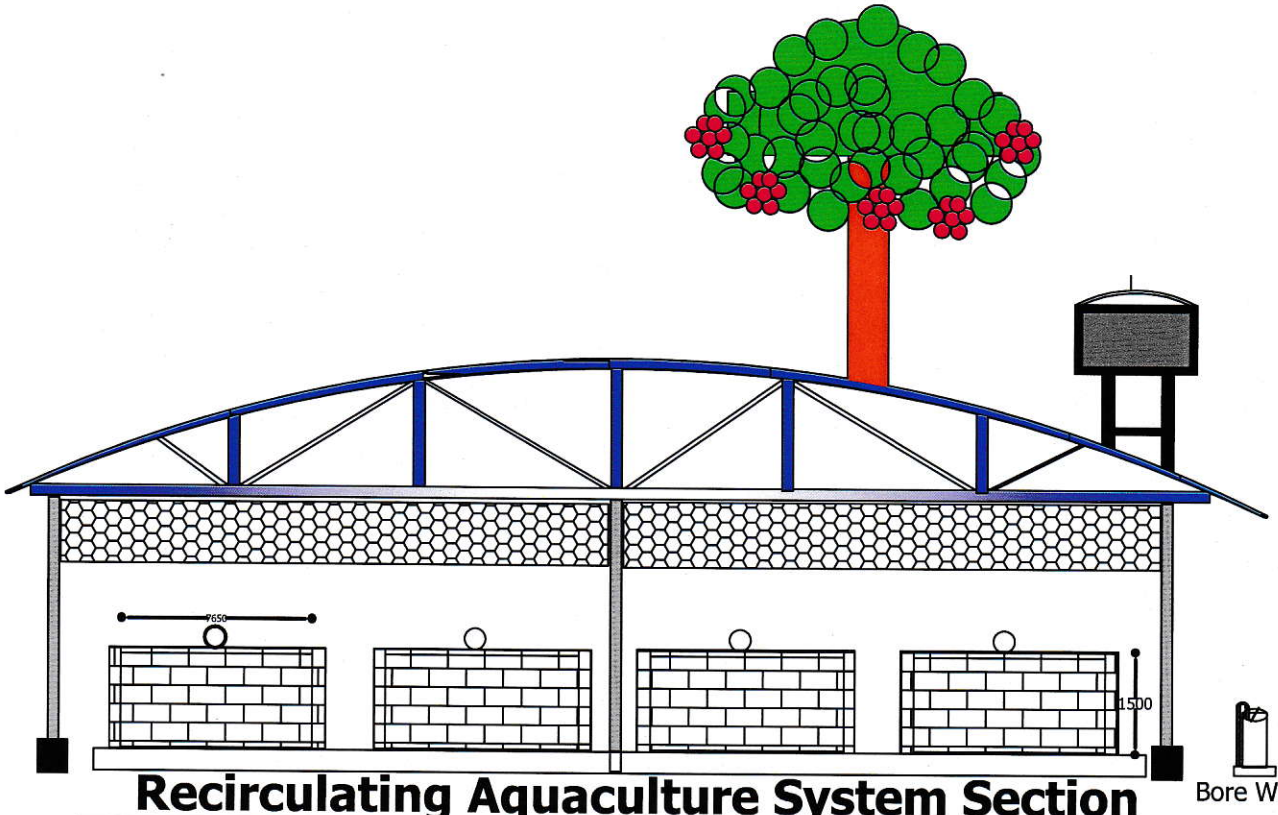
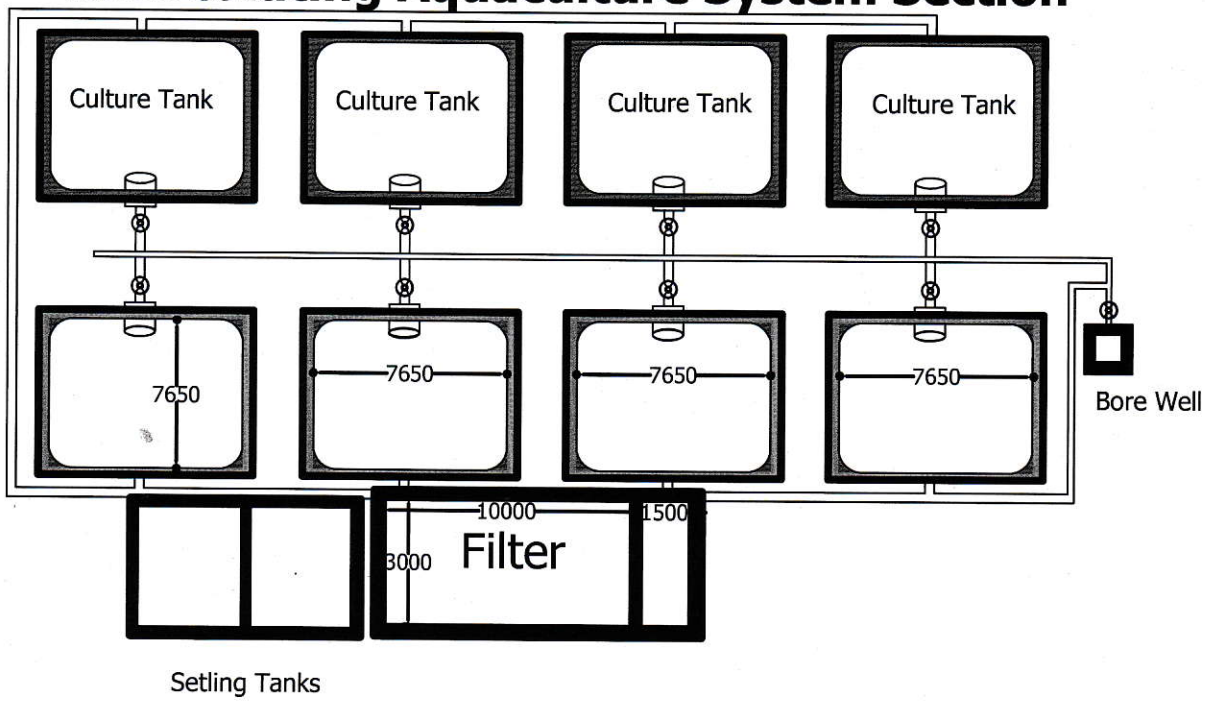
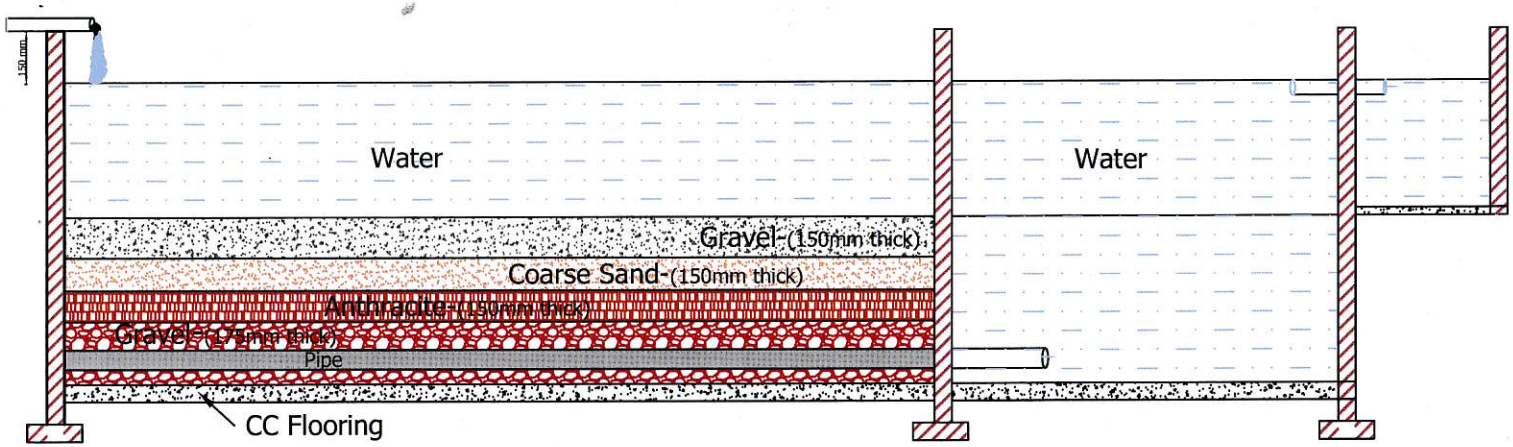


Recirculating Aquaculture System Section

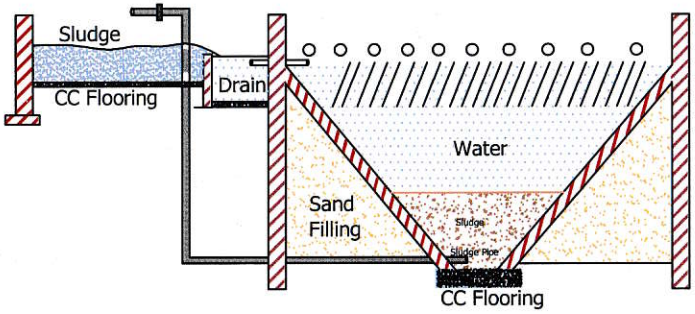


Recirculating Aquaculture System Plan

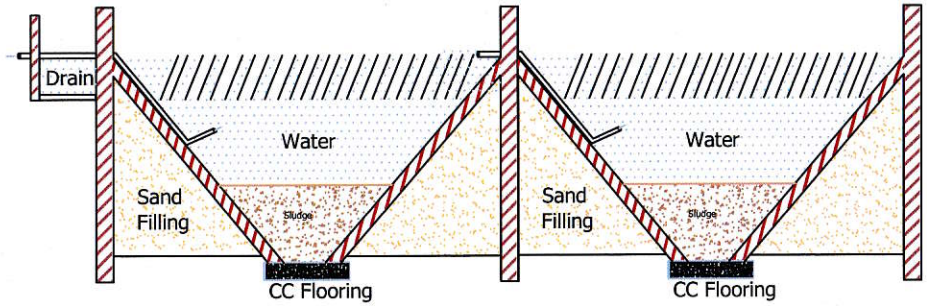
Bio Filters



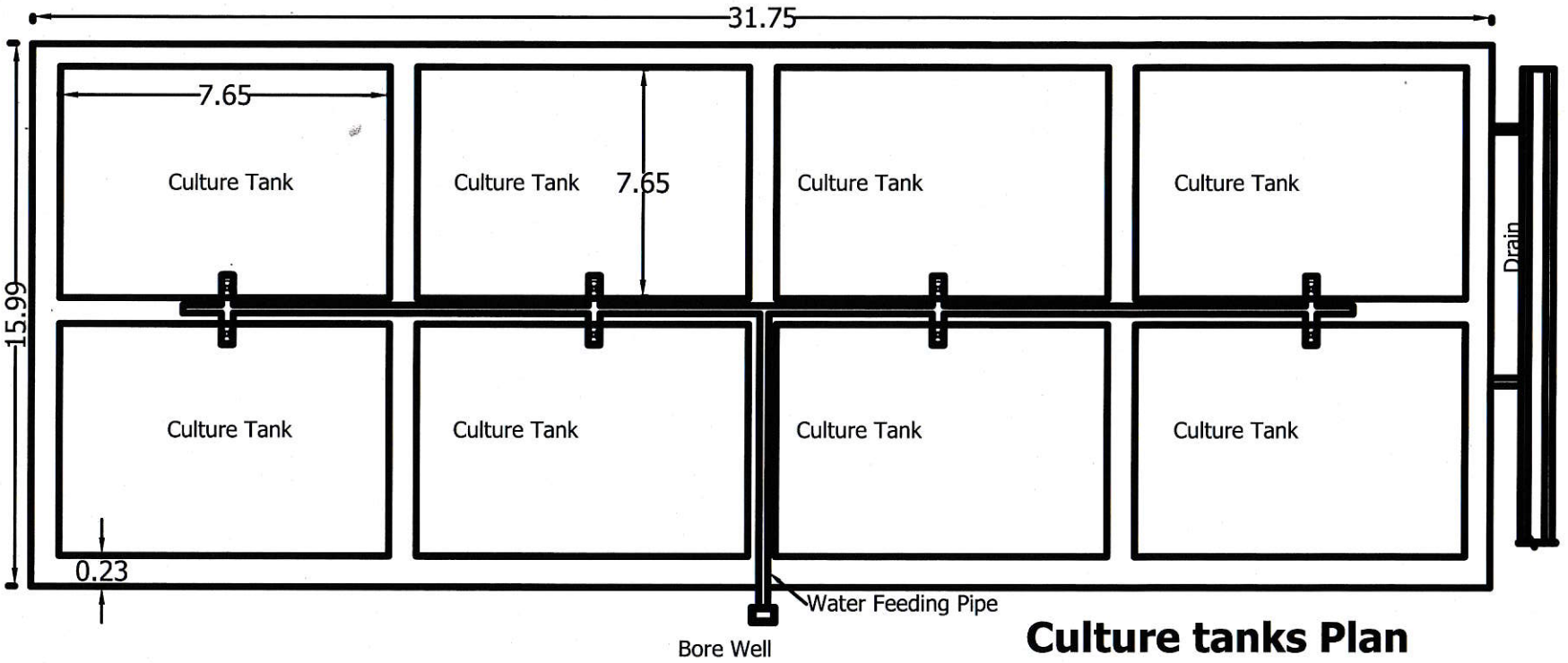
Sand Filter- Cross Section



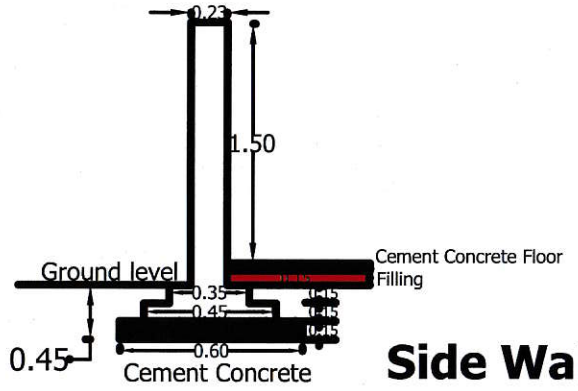
Setling Tank - Cross Section



Setling Tank - Cross Section



Culture tanks Plan



Side Wall Section