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A CONCEPTUAL APPROACH OF INFILTRATION GALLERY IN AQUACULTURE SYSTEM TO REUSE THE INFILTRATED WATER

Monikandon Sukumaran[1,*], Mohammad Tanveer[2,*] and Kesavan Devarayan[3]
[1]Department of Basic Engineering, College of Fisheries Engineering,
Tamil Nadu Fisheries University, Nagapattinam 611 001, Tamil Nadu, India
[2]Department of Aquacultural Engineering, College of Fisheries Engineering,
Tamil Nadu Fisheries University, Nagapattinam 611 001, Tamil Nadu, India
[3]Department of Basic Sciences, College of Fisheries Engineering,
Tamil Nadu Fisheries University, Nagapattinam 611 001, Tamil Nadu, India
E-mail: monicivil.engineer@gmail.com, nobletanveer@gmail.com (**Corresponding Author*)

Abstract: A new approach for reuse of aquaculture water is described in this article. Generally, the aquaculture water goes waste due to seepage and infiltration from the entire pond. In fact, after every culture the water is disposed without any further use. Also there is a huge shortage of fresh water for culture at summer. Moreover, the ever increasing population demands for pure water. Therefore in this present study a simple and efficient approach has been applied to use infiltrated water efficiently in aquaculture ponds.
Keywords: Aquaculture, Infiltration gallery, Reuse, Infiltrated water, Aquaculture ponds.

Introduction

Generally, fish and shellfish farming possess potential opportunities for diversification and profitability in any aquaculture venture. In most cases, the production of these fishes is performed in ponds, which are generally built by constructing levees around a portion or all of the water that is to be impounded. Some of these ponds are filled by runoff but the majority is filled with water pumped from wells (groundwater). Some precipitation falls into the ponds but most of the water comes from wells [1-5].

The water budget for the average aquaculture ponds is $P + WR = (S+E) \pm \Delta V$, where P= Precipitation; WR = Water required from wells/ other sources; S = Seepage; E = Evaporation and ΔV = Change in storage.

Water supply for irrigation/fish culture and domestic use is obtained in many areas of Southern part of India is of critical importance. The present approach focuses on reuse water for the purpose of drinking, fish culture, and daily use. Draining of cultured-water into streams is a potential source of water pollution. It should be noted that the cultured-water is high in organic and inorganic nutrients. Therefore it can be used to fertilize pastures or other crops. Reusing this water in the same or other ponds reduce the pollution potential and

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eliminates the cost of refilling the ponds. Therefore, in the present study a conceptual approach of construction of infiltration gallery has been provided to reuse infiltrated water for aquaculture and daily use [5-10].

Infiltration gallery is an artificial aquifer/groundwater storage tank installed below the bed of ponds, rivers, streams or other surface-storage to collect fresh water that is skimmed off the surface water. River or ponds with sandy soils are suitable for construction of infiltration galleries [8-14].

Need of Infiltration Gallery

As the groundwater availability is less during the summer, the aquaculture farmers have to wait for the availability of good quality of water. Another one important reason is that the quantity of the water initially stored by the farmers for the culture of the fish will be of good quality or desirable but some quantity of the water will be wasted as seepage. The possible methods for the seepage of the stored water for culture from the pond are by seepage through the bund of the culture pond and other seepage through the bottom of the culture pond. The seepage through the bund of the culture pond can be reused by providing an infiltration gallery. The infiltration gallery is a suitable solution for economic use of the infiltrated culture water. The water entering in to the infiltration gallery has to infiltrate through the natural ground strata or permeable strata provided and hence self cleaning or natural cleaning of the suspended particles in the water will occur [1, 2, 8]. Moreover the chemical disinfectant used for disinfecting water before culture can be reduced as the water entering the gallery has undergone natural cleaning, the leaching of the nutrients and salts will occur. Therefore the dissolved solids in the water will be less when compare to the natural/surface source water. For design of infiltration gallery most important parameters required are estimates of saturated hydraulic conductivity, hydraulic conductivity for layers of soils.

Approach: A Conceptual Design

The concept of infiltration gallery depends on Darcy's law which describes the flow of a fluid through a porous medium. It states that velocity of flow in a porous medium is directly proportional to the hydraulic gradient.

$$v \propto i \quad (1)$$

$$v = Ki \quad (2)$$

Therefore, Discharge $$Q = KiA \quad (3)$$

where, v = velocity of water in porous medium; K = permeability; i = hydraulic gradient; A = area of porous medium.

Estimation of Saturated Hydraulic Conductivity from Soil Information

The estimation of grain size based on the soil characteristics present in different layers in the site gives a reliable data and more accurate results of the saturated hydraulic conductivity of the area. Other tests such as laboratory permeameter tests, air conductivity measurements, infiltrometer tests, and pilot infiltration tests can also be used for measuring the saturated hydraulic conductivity from the soil information. Of all the above methods one of the most simple and most commonly used approach is the Hazen equation.

$$Ks = Cd^2_{10} \qquad (4)$$

where K_s is the saturated hydraulic conductivity, C is a conversion coefficient and is approximately unity 1, and d_{10} is the grain size for which 10% of the sample is more fine (10% of the soil particles have grain diameters smaller than d_{10}).

Hydraulic Conductivity Estimates for Layered Soils

The soil samples should be collected at horizontal layers in the site. For every layer in horizontal at least 2-3 soil samples should be collected and the effective or equivalent hydraulic conductivity can be estimated by using Hazen equation. Hydraulic conductivity estimates from different layers at a single horizontal location can be combined using the harmonic mean by the following equation.

$$K_{equiv} = \frac{d}{\sum \frac{d_i}{K_i}} \qquad (5)$$

where *d* is the total depth of the soil column, *di* is the thickness of layer *i* in the soil column, and *Ki* is the saturated hydraulic conductivity of layer *i* in the soil column. The depth of the soil column, d, would typically include all layers between the pond bottom and the water table.

Construction

The first and foremost point regarding infiltration gallery is that it should lie below the ground level about 3-5 m deep. Gallery should be made up of brick masonary wall to prevent the storage loss of infiltrated water. The top of the infiltration gallery should be covered with RCC slab. The gallery should have numerous lateral drains covered by porous material like gravels. All these lateral drains will be connected to horizontal tunnel drain to take infiltrated water to the gallery for use.

The width of the infiltration gallery should be at least 1 m, but there is no restriction for that i.e. it be as broad as the need of the quantity of water. The length varies from 10 m to 100 m (depends on requirement).

Maintenance

Water entering gallery generally contains some sediment load and is deposited in the bottom of the gallery and which should be removed from time to time. To remove sediment load from the galleries manholes are usually provided at every 5 m along each lateral. These manholes provide place for washing of any accumulated sediment down into the sump where it can be easily removed. The manholes can also be used to check if the pipe has collapsed or been damaged.

Conclusion

Infiltration galleries, if provided in the aquaculture system, can provide a cheaper solution for getting water continuously for culture. Water with less pollutant and microbes that are harmful for the fishes is available at cheaper cost more over the productivity of the water is more. The provision of using infiltration gallery will reduce the treatment cost of the water when compared to other source water. The quantity and quality of the water will be also reasonable.

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