Journal of Basic and Applied Engineering Research
Print ISSN: 2350-0077; Online ISSN: 2350-0255; Volume 2, Number 11; April-June, 2015 pp. 947-950

http://www.krishisanskriti.org/jbaer.html

Development of Inclined Cascade Aerator

Himanta Doley[1*] and Avinash Kumar[2]

[1]Dept. of agricultural Engineering, Assam University Silchar-788011*
[2]Assam University Silchar
E-mail: [1]doleyhimanta@gmail.com, [2]avinashiitkgp86@gmail.com

Abstract—*Abstract: Aeration system is very much essential for the management of pond. Aeration is a beneficial and safe technique to improve any body of water. By insuring that oxygen is thoroughly mixed into the entire water column to the sediment-water interface the livable space is increased for the fish within, phosphorus remains bound and nutrients are reduced. All of this leads to a healthier more easily managed lake or pond. Various types of aeration systems have been developed over the years to maintain the oxygen level in a pond but for economical, efficient and eco-friendly is the urgent needed for the time being. Inclined cascade aeration system will be the best alternative for that. In this system of aeration, it is simply and easy to used for the farmer. The maintaining cost is very less as compared with other type of aeration system. The main sources of energy used in this type of aeration system is gravity flow of water, due to which, it is more economic than other type of aeration system. The height of the inclined cascade aeration is varying from 0.5m to 2m and the numbers of barriers provided is from 0 to 7 numbers. In this type of aeration system, according to needed the barriers height can be also varying from 0 to 10 cm but most efficient is 10 cm. The inclination angle of the inclined cascade aerators is from 30^o to 80^o, more the inclination angle more efficient can be found out. This type of aerators has mainly three parts namely i) inlet tank, ii) inclined part, and iii) outlet tank. The cost of the aerators can be reduced up to 40 to 60 %, for practical used due to reduction of its part.*

Keywords: *Aeration, efficiency, barriers, inclination*

1. INTRODUCTION

Aeration is often the first major procedure at the treatment plant. During aeration, constituents are removed or modified before they can hamper with the treatment processes. Aeration brings water and air in close contact by exposing drops or thin sheets of water to the air or by introducing small bubbles of air (the smaller the bubble, the better) and letting them rise through the water. The scrubbing process caused by the turbulence of aeration physically removes dissolved gases from solution and allows them to escape into the surrounding air.

1.1. Background

The most logical means of improving oxygen regimes of cultured fish is by gravity fall of water between production units, which is provided by the topography at facility. The extent to which water is re-aerated by gravity is of fundamental concern for practical fish culture. There is no operating cost usually associated with it because head loss provides the energy for gravity aeration. Gravity aeration can be accomplished by passage of water over a simple weir, an inclined sheet of corrugated roofing, or a closed stair-step arrangement called cascades. During the fall of the water, bubbles rise up as air gets dragged in. Gas exchange occurs between the air in these bubbles and the water. Oxygen diffuses from the air into the water and helps to increase the DO content of the water. In rivers, artificial stepped cascades and weirs are generally introduced to enhance the DO content of polluted or entropic streams [3]. In-stream stepped cascades are also built downstream of large dams to re-oxygenate water, e.g., Chatuge weir built by Tennessee Valley Authority [15,16,17]. Another example is the series of five aeration cascades built along the Calumet waterway in Chicago [8,20]. The waterfalls are designed to re-oxygenate the polluted canal and are landscaped as leisure parks, combining flow aeration and aesthetics. With large dams, nitrogen super saturation might also occur and increase the mortality of some fish species. Stepped cascades could be used to reduce the dissolved nitrogen content. In the treatment of drinking water, cascade aeration is used for reoxygenation, denitrification [18], removal of volatile organic components (VOC) such as methane and chlorine [21,22], dissolved iron and manganese, carbon dioxide, hydrogen sulphide, as well as the colour and tastes caused by volatile oils.

Many research works have been conducted on stepped cascade, which are mainly concerned about dam spillway. To date, no literature exists on the development of an inclined cascade system. In aquaculture the inclined cascade may be used for preaerating the groundwater or surface water before discharging into the pond or as a post aeration unit, i.e., aerating the effluent again before discharging into surrounding water bodies. The inclined cascade design may also be adopted in raceway system provided the topography allows for the necessary slope for gravity aeration. For the economical point of view, there is urgent need for the economic and more efficient aerators system. In this project, efficiency and economic is given more importance.

1.2. Objective

Keeping in view of the above discussion, the following objective is taken up for the present study:

1. Cost estimation of design inclined system (ICA).
2. Fabrication of inclined cascade aerators (ICA).
3. Installation of the inclined cascade aerators (ICA).

2. MATERIALS AND METHOD

In this part of my work is to explain the materials needed and the methods adopted for the development of the inclined cascade aerators system (ICA).

2.1. Materials

The main materials need for the development of the ICA is angle iron bar and iron sheet for the fabrication purposed. In the cost estimation parts it is clearly explained the amount needed. Given below are the some of the part of the ICA.

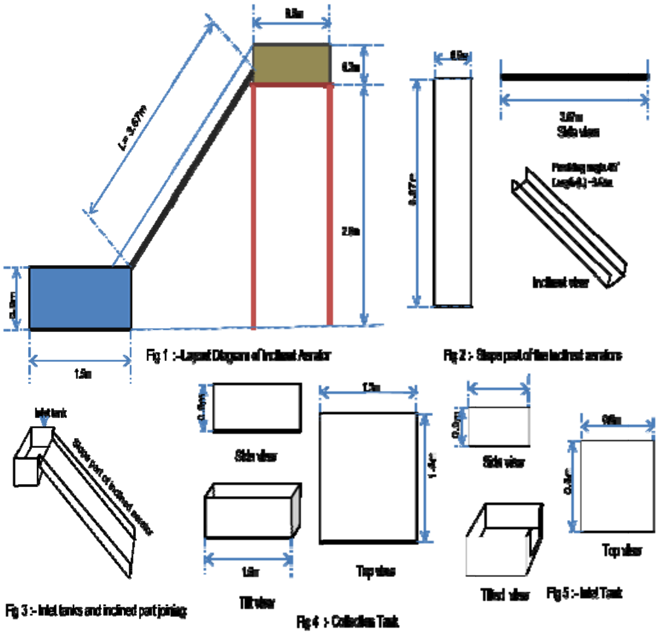

Fig. 1: Diagram with dimension

2.1.1 Inlet tank

Inlet tank is made of iron metallic sheet. The dimension of inlet tank is length 0.6m, breath 0.5m, height 0.6 m. Capacity of the inlet tank is 180 L. Given below are the some of the picture.

Fig. 2: Inlet Tank

2.1.2 Outlet tank

The outlet tank is made of iron metallic sheet of dimensions, length 1.5 m, breath 1.5m and height 0.5 m. This tank is used to collect the aerated water and recirculation purposed. The capacity of the outlet tank is 1125 L. Given below are the some of the pictures of outlet tank.

Fig. 3: Outlet Tank

2.1.3 Inclined part

The length of the inclined part is 3.68 m, breath is 0.5m. This inclined part is connecting the inlet and outlet tank. The water from the inlet tank is flows over through the inclined part and reaches the outlet tank.

Fig. 4: Inclined Parts

2.1.4. Barriers

The barriers are made of plywood, of different height 2cm, 4cm, 6cm, 8cm and 10cm of 50.5 cm thickness. These barriers are fixed in the inclined part with the help of L-angle bar. The barriers is inserted or used in this project mainly for the disturbing the flow. In order to make the flow turbulent and mixed flow, in which more surface of water will exposed to the air and hence more aeration.

2.1.5. Centrifugal pump

Centrifugal pumps are the most preferred hydraulic pumps used in domestic and industrial world. Centrifugal pumps are used to induce flow or raise pressure of a liquid. It is used to raise the pressure of the water so that the water flows from ground level to inlet tank. 2hp electric pump is used here.

2.1.6. Supporting Structure

In this setup, there are two type of supporting structure, one is for support the inlet tank and another is for the outlet tank. The supporting structure for the inclined cascade aerator system is made of iron angle bar, Brick and cement mortars. . It is the platform of the cascade aerator. Outlet tank is placed on the supporting structure. It is constructed by bricks of 1.2 m length and 2.4 m breadth. For the outlet tank, the dimension is height 2m, length is 0.6m and breadth is 0.6m.

Fig. 5: Supporting Structures

3. RESULTS AND DISCUSSIONS

3.1. Estimated Cost

Table 1: Cost Estimation for Inclined Cascade Aerator

Sl. No	Item Details	Nos.	Weight kg	Rate/kg	Cost (Rupees)
1.	L- Angle Bar (IRON)		30	60	1800
2.	I- Angle Bar		25	60	1500
3.	Metallic Sheet	4		800	3200
4.	PVC Pipe (10 feet)	2		230	460
5.	Centrifugal Pump	1		5200(Approx.)	5200
6.	Works Shop			1500	1500
7.	Fabrication Cost			3000	3000
9.	Primer (Iron Oxide)		1 litre	130	130
10.	Plywood			700	700

Above given is the cost for the fabrication of inclined cascade aerators system. But, for the practical used for the pond 40% of it cost can be reduced because in practical used only inclined part is need but for the experimental setup, the whole part including inlet tank and outlet tank is also needed.

3.2. Fabrication of Inclined Cascade Aerators (ICA)

For the experimental setup, fabrication is done. Given below are the some of the image from the workshop while fabrication of inclined cascade aerators.

Fig. 6: Overall view of Inclined Cascade Aerators system while Fabrication

3.3. Installation

Inclined cascade aerators (ICA) consisting of three parts namely inlet tank, incline part and outlet tank. In order to install the setup at the experiment site, the ground is level first and for the outlet tank, a basement is constructed. After that whole the parts were assemble and connected to each other as shown below in the plate 4.2. A pipe in connected to the outlet tank for the re-circling of water while aeration. Another end of the pipe is connected to the inlet of the centrifugal pump. The outlet of the centrifugal pump is connected to the inlet tank.

Fig. 7: Overall View

4. CONCLUSIONS

For the designing, the better efficient and less maintenances cost for the aerators, it will be the best alternative for that. Inclined Cascade Aerators is easy to used and easy to maintain. The cost of inclined cascade aerators is less as compared to other types of aerators. Inclined Cascade Aerators mainly operated on gravity flow of water, due to which it consumed less energy as compared to other types of aerators system. It is more eco-friendly.

5. ACKNOWLEDGEMENTS

The author acknowledges the financial help and laboratory facility from Assam University Silchar, Assam. The program is under the partial fulfillment of M.Tech project in Water Resources Development and Management Engineering under Dept. of Agricultural Engineering for Himanta Doley.

REFERENCES

[1] Ahmad, S. Packed-Tower Aerators put end to VOCs. Water Engg. & Mgmt. (Nov. 1985).

[2] Apted, R. W., and Novak, P. 1973. “Oxygen uptake at weirs.” Proc., 15th IAHR Congress, Vol. 1, Istanbul, Turkey, 177–186.

[3] Avery, S. T., and Novak, P. 1978. “Oxygen transfer at hydraulic structures.” J. Hydraul. Div., Am. Soc. Civ. Eng., 10411, 1521–1540.

[4] Brace H. Boyden, Duong T. Banh, Houston K. Huckabay and Joseph B. Fernandes, *Journal (American Water Works Association),*Vol. 84, No. 5, Small Systems (MAY 1992), pp. 62-69

[5] Boyd, C.E. and F. Lichtkoppler. 1979. Water quality management in pond fish culture. Research and Development Series No. 22, International Center for Aquaculture, Agricultural Experiment Station, Auburn University, Auburn, AL.

[6] Boyd, C.E. 1998. Pond water aeration systems. Department of Fisheries and Allied Aquacultures, Auburn University, Auburn, AL, Vol. 18, Issue 1, Pages 9–40.

[7] Brett, J.R. 1979. Environmental factors and growth. In: W. S. Hoar, D. J. Randall, and J. R. Brett (Eds.), Fish Physiology. Vol. 8. ed. Academic Press, London and New York, pp. 599–675.

[8] Cargill, G.D.(1994).’Water Quality in the Windy City.” Water Environ. & Technol., Vol 6, No 6, No 9, pp. 52-56.

[9] Chanson, H. (1994). Hydraulics of Nappe Flow Regime above Stepped Chutes and Spillways. Aust. Civil Engrg Trans., I.E.Aust., Vol. CE36, No. 1, Jan., pp. 69-76.

[10] Chanson, H. and C.A. Gonzalez, 2005. Physical modelling and scale effects of air-water flows on stepped spillways. J. Zhejiang Univ. Sci. A, 6: 243-250.

[11] Chanson, H. and L. Toombes, 1997. Flow aeration at stepped cascades. Research Report No. CE155, Department of Civil Engineering, University of Queensland, Australia, pp: 1-110.

[12] Chanson, H. (1996). Prediction of the Transition Nappe/Skimming Flow on a Stepped Channel. Jl of Hyd. Res., IAHR, Vol. 34, No. 3, pp. 421-429.

[13] Chanson, H. and Gonzalez, C. A. (2005). Physical modelling and scale effects of air-water flows on stepped spillways. Journal of Zhejiang University Science 2005 6A(3):243-250.

[14] Francis-Floyd, R. 2003. Dissolved oxygen for fish production. Fact sheet FA–27. Department of Fisheries and Aquatic Sciences, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL.

[15] Hauser, G.E. and D.I. Morris, 1995. High-performance aerating weirs for dissolved oxygen improvement. Proceedings of the International Conference on Hydropower, Volume 2, July 25-28, 1995, San Francisco, USA., pp: 1695-1705.

[16] Hauser, G.E. and D.I. Morris, 1995. High-performance aerating weirs for dissolved oxygen improvement. Proceedings of the International Conference on Hydropower, Volume 2, July 25-28, 1995, San Francisco, USA, pp: 1695-1705.

[17] Hauser, G.E., J.A. Niznik, W.G. Brock and R.M. Shane, 1992. Innovative reregulation weirs. Civil Eng., 62: 64-66.

[18]]Hoek, J.P. van der, Kappelhof, J.W.N.M., and Hijnen, W.A.M (1992), “Biological Nitrate Removal from Ground Water by Sulphur/Limestone Denitrafication.” Can.Jl of Chem. Eng., Vol. 54, Feb., pp. 197-200.

[19] Huckabay, H.K. & Keller, A.G. Aeration on an Inclined, Transversely Corrugated, Solid Surface. Jour. WPCF, 42:R202 (May 1970).

[20] Robinson, R. (1994). “Chicago’s Waterfalls.” Civil Engineering, ASCE, Vol, 64, No. 7, pp. 36-39.

[21] Toombes, L , H. Chanson, 2005. Air-water mass transfer on a stepped waterway. J. Environ. Eng., 131: 1377-1386.

[22] Toombes, L., H. Chanson, 2000. Air-Water Flow and Gas Transfer at Aeration Cascades: A Comparative Study of Smooth and Stepped Chutes. In: Hydraulics of Stepped Spillways, Minor, H.E. and W.H. Hager (Eds.). A.A. Balkema Publishers, Netherland, ISBN-13: 9789058091352, pp: 77-84.