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Popular Article

Venturi in Aquaculture Engineering

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Dissolved Oxygen (DO) is the single most important water parameter that makes shrimp or fish survive in the water and aquaculture production possible. Maintaining optimum DO levels in the pond water for high productions of shrimp or fish for maximum profitability in intensive aquaculture systems is just not possible without proper aeration to cope up with the necessary high feeding and stocking rates. The necessity of aeration in aquaculture systems is now accepted mostly by Industry. But there is still some controversy as to which is the most efficient method of aeration and circulation. We are going to introduce an efficient aeration which is combined with water current using a simple small device: Venturi. By aeration with venturi, we not only supply DO but also provide water current which is the same importance as aeration.

Aerators

There are two main types of aerators. One is the Splasher group which sends water drops into the air such as paddle wheel, vertical pump, and sprayer, and the second group is Bubbler which sends air bubbles into the water such as aspirator, venturi, and diffuser.

The most efficient aerator in the first group is paddle wheel and in the second group is venturi, in terms of DO increment per energy unit and current creation in the water.

Venturi General Design

Venturi is a simple pipe with a Throat inside of the water route and the pressure will be decreased in this section. The negative pressure will suck air from a small pipe at the top. The air bubbles will mix with the water and a mix of water and small bubbles will jet out from the outlet. Two main functions will occur in this process, firstly mixing water and air will increase the DO level in the water due to diffusion effect, and secondly, the water jet will create water current in the tank. It is a very simple and effective way for oxygenation and circulation. The basic design of the venturi is given in Fig.1.

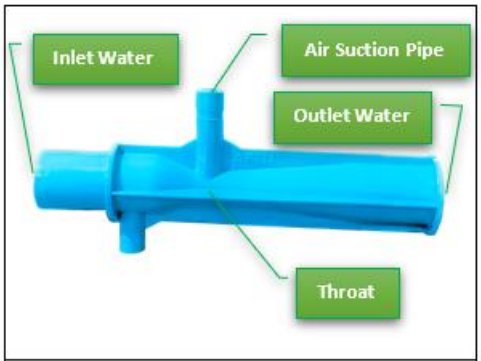

Fig.1- Basic design of the venturi

Venturi Maximum Installation Depth

The maximum depth for installation shall be calculated by this equation:

$$H_{max} = \frac{Q^2}{40}\left[\frac{1}{D_2^4} - \frac{1}{D_1^4}\right]$$

H_{max}: Maximum depth for Venturi installation (m)
Q: Discharge (m^3/s)
D_2: Diameter in throat (m)
D_1: Diameter in the entrance (m)

A depth of more than 60 cm will decrease the efficiency of the venturi but will aerate the lower layers of the water. Decision on the depth of installation depends on several items and the farm manager shall decide.

General layout of installation

There should be a ring pipe around the tank and connections shall be jointed in different parts of the ring pipe. Ring pipe can be installed at the top of the tank as well as inside the tank, depending on the conditions. Several samples of the venturi arrangements are shown in Fig.2, 3, and 4. Fig.5 shows water jet created by AFTM venturi.

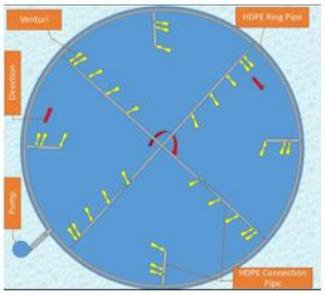

Fig.2- A sample of venturi arrangement

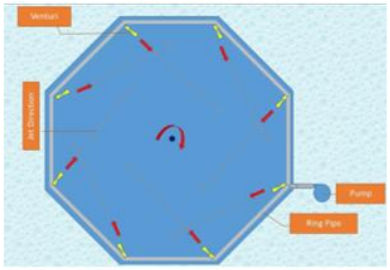

Fig.3- A sample of venturi arrangement

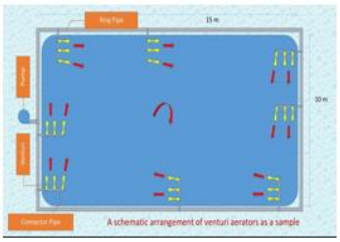

Fig.4- A sample of venturi arrangement

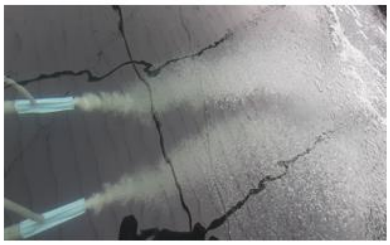

Fig.5- A sample of venturi water jet

Ring Pump Diameter

The pump gets water from the tank and sends to the same tank ring pipe. The diameter of the ring pipe depends on the discharge and the discharge depends on the venturi discharge and number of the venturies. If the pipe diameter comes down, the water velocity goes high, and the energy losses will rise. On the other hand, the higher diameter of the ring pimp means higher investment. The normal velocity of the water in the pipe is shown in Fig.6.

Water velocity in the ring pipe (m/sec)	
<1	Reduce the pipe diamater
1-1.5	Diamater is ok, but you can reduce too
1.5-2	Diamater is ok
2-2.5	Diamater is ok, but you can increse too
>2.5	Increase the pipe diamater

Fig.6- Water velocity in the ring pipe

Pump type

The most suitable pump for a venturi system is a high discharge and low-head, centrifugal pump. To run a venturi there is no need for high-pressure water, but need a high volume of water to be pumped. Normally in most conditions, the head is less than 1 bar. To supply the most suitable pump for your system, you shall follow these steps:

- Choose the venturi discharge
- Find the number of the venturies and calculate the total pump discharge
- Calculate the head loss in the pipes
- Consider 5-6 m head for the venturi and add to the head loss to find the pump head
- Order a pump with the such discharge, head, and rotation of 1450 RPM.

Unit Exchange

There are different units for your calculations. These equations are useful:

- 1 feet = 30.5 Cm
- 1 In = 2.54 Cm
- 1 lit/sec means one liter per second
- 1 m^3/sec = 1000 lit/sec
- 1 m^3/sec means one cubic meter per second
- 1 m^3/hr = 3600 m^3/sec
- 1 m^3/hr = 3.6 lit/sec
- 1 gpm = 3.79 lit/min