Aeration 101

By John "Big John" Koeniger

Aeration is the addition of oxygen into water with the use of ambient air or pure oxygen. Additional oxygen is needed in water to offset the deficit created by the breakdown of waste, consumption by fish and/or need of algae. Before we discuss the different types of aeration and the equipment used to aerate, we must understand Volume, Pressure and Friction.

Volume refers to an amount of space. Pressure refers to the amount of force. If we were to blow up a birthday balloon we would see the volume inside the balloon increase as the balloon fills with air and gets bigger. If we were to let the balloon go when it is full of air, it would launch as the pressure releases quickly with a lot of force. If we were to stretch the neck of the full balloon, it would screech releasing the pressure slowly with little force. Friction interferes with pressure. If we were to insert a straw into the balloon to blow it up, we would not only get a headache, but we would have a difficult time getting enough air into the balloon to fill it. On the reverse side of this, we would notice the balloon takes some time to deflate when the air exits the straw. This is due to friction which slows down the airflow requiring more pressure, or force, to overcome the friction or friction loss.

There are many types of aerators, but for discussion purposes we will limit this selection to those most commonly used in aquaculture, aquaponics and hydroponics. The most commonly used aeration devices in these 3 segments of agriculture include diffused air systems, water pump driven systems and mechanical aeration.

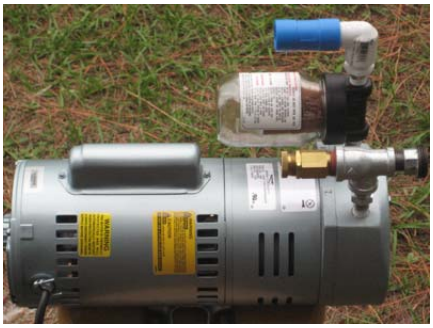
Diffused Air Systems

Diffused air systems include those in which an air compressor of some type is used to provide compressed air to a diffuser which is suspended down into the water. The 3 most common types of air compressors used are regenerative blowers, rotary vane compressors and linear piston compressors. The advantages and disadvantages follow:

Regenerative blowers provide a large amount of air (volume) at a low pressure. These types of blowers are a very good choice when needing air for a large number of air stones or drilled pipe in applications shallower than 4 feet deep. They are a simple device in which an impeller is mounted to a motor shaft and the impeller spins at a high rpm producing lots of air. They traditionally will operate for periods up to 5 years with little or no maintenance other than cleaning the air intake screen. The drawback to regenerative blowers is that they only produce air to about 4' of depth. In applications deeper than 4', the diffusers must be raised or a different compressor needs to be considered.

Regenerative Blower

Rotary vane compressors provide a medium amount of air at higher pressures (4 -18 feet). These compressors are a good choice when air is needed at deeper depths. An example application would be the aeration of a deep nutrient storage tank. The shaft from the motor connects to a round rotor with 4 slots. Carbon vanes fit within these slots and as the offset rotor spins, the vanes slide out against the outside wall and compress the air while forcing it out of the housing. The vanes will last 9 months to a year. The downside of vane type compressors is the carbon dust which escapes the outlet, vane maintenance and the cost of the compressor vs. the regenerative blower.



Rotary Vane Compressor

Linear piston compressors produce even less air than the rotary vanes, but are very quiet and energy efficient. The linear pistons produce a relatively small amount of air at medium pressures and are useful for aerating small systems. Linear piston compressors produce enough air for up to six 9" diffusers at a depth of 5'. Most linear piston compressors on the market have a sideways piston which moves left to right compressing air and sending it out of the outlet. Linear piston compressors will need to be rebuilt every 10,000 hours (1.1 year) of operation. The only downside to linear piston compressors is the small amount of air they produce.

Linear Piston Compressor

Water Pump Driven Systems

Water pump driven aeration systems would include spray bars, venturi's, oxygen saturation cones and water mixers. Each of these techniques is described below:

Spray bars are actually as simple as they sound. A pipe is drilled with small holes and forces the water to be sprayed out if it. This allows for degassing as well as aeration. This technique works well on water pumps that carry a medium to high head pressure. The smaller fractional hp high flow pumps traditionally do not have enough pressure to drive a spray bar.

Venturis are used to "suck" air into a pipe and mix it with water. Medium and high head pumps have enough pressure to allow installation of a venturi device which restricts water flow creating a suction force which draws air into the venturi from a draft tube above. The flow of water and the available pressure determine how much air can be drawn in. Please note that the water flow volume and pressure will both be reduced when using a venturi. Pure oxygen can also be used in this application with mild efficiency. The water dis-

charge should remain underwater when using pure oxygen so that any un-dissolved gas has some chance to diffuse into the water instead of venting into the atmosphere when falling back into a tank.

Oxygen saturation cones are round, pot-belly fiberglass vessels which are designed internally to allow the water flow to slow while dropping down through the cone. This motion creates a continuous mixing of pure oxygen and water allowing super saturation of oxygen into the water. Water flow is regulated on the outlet of the cone via a valve and short section of clear pipe. Oxygen gas is introduced upstream of the cone or in the neck of the cone and is regulated by a flow meter. The clear pipe allows inspection of the discharge water to ensure it contains zero bubbles. Dialing in the flow rate this way allows for almost 100% efficiency.

Water mixers work very similar to venturis but do not allow any ambient air into the equation. The mixers are designed to create a little back pressure so that system water is mixed with water coming through the pipe to increase flow by as much as 5 times. Water mixers are relatively cheap and are easy to install. A small net gain in aeration due to increased water movement could be expected.

Mechanical Aeration

Mechanical aeration is acheived by the use of a driving motor to a spinning blade, prop or paddle-wheel. Normally this type of aeration is reserved for very large systems and facilities. Regardless of the style, mechanical aerators will need a power source in the water and often times include a submersible motor.

Conclusion

As you can see there are many types of aeration systems to choose from. Each has its strong suits as well as its drawbacks. In the next segment I write on aeration, I will address application specific choices and discuss aeration in more detail. Stay Tuned!

About the Author: *John "Big-John" Koeniger has been designing, installing and consulting on energy efficient aeration system design and filtration to the Aquaculture, Aquaponic and Hydroponic industries for 18 years. Big-John is president of Mightyfish, Inc. and can be reached at bigjohn@mightyfish.com*