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Shellfish Upweller Silo Construction: 101

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An integral part of shellfish aquaculture is the nursery phase. It follows the hatchery phase where the shellfish are spawned, swim in a larval tank for a couple weeks, then metamorphose from free swimming larvae and "set", in the case of oysters on some substrate, and for clams onto the bottom of the larval tank. The next step is usually a downweller where phytoplankton-rich water runs into the top of a silo that sits in a tank of sea water. This technique keeps the newly set and extremely light post-set from flowing up and out of the silo. When they grow a bit larger, the tiny seed can go into an upweller silo. The water will enter from the bottom of the silo and flow out through a fitting in the side of the silo. Seed will stay in the upweller until they are either moved into a growout phase, or put into a raceway for further growth before field planting (Figure 1).

Figure 1. A typical upweller silo in use.

There are two styles of silos, cylindrical and square. Some growers have personal opinions about which works best, but both seem to get the job done.

This fact sheet will address the method for constructing a cylindrical silo. The material used is up to the grower, and some have constructed fiberglass silos, used 5-gallon buckets, and even, cut down 55-gallon plastic barrels, but thin-walled 14- or 16-inch diameter PVC duct pipe has been a very workable choice for many operators. It is a bit expensive to start with, but the material will likely last for years; it's tough, doesn't breakdown in sunlight, and is fairly light. Some silos are easily over 20 years old, although the mesh may have been changed over time.

The construction process is not difficult, but may require at least two people to handle various parts of the construction.

The first thing to know is how deep the upweller tank is. The silos should have a few inches of clearance below them so the water flow will be better. The silos will couple to either the side of the tank, or to a sluice box in the center of the tank where the water exits back to the source. Therefore, several holes are required to be cut in to the PVC cylinder to allow for support of the silo and connection to an exit for the water.

Cutting the silos

Duct pipe typically comes in 20-foot lengths, so cutting it to a usable size for silos will require some power tools (Figure 2). Some growers might have a steady enough hand to use a jigsaw or hand-held circular saw, but it can result in jagged cuts that will be problematic later in the construction. A table saw with a jig to hold the large duct pipe works well (Figure 3).

Figure 2. A standard length of 16" PVC duct pipe to be cut into silo sections.

The jig can be made of plywood and must be well clamped to the table saw. It should have a movable fence to maintain the desired length of the individual silo, but can also be shortened to cut the extra bands that are used to hold the screening material tight on the silo itself. A hole for the blade to pass up through the jig can be made by securely clamping the jig bottom down on the table saw and raising it up slowly through the plywood. A set of spaced small rollers screwed to the jig surface will facilitate the turning of the duct pipe for cutting.

Once the jig is constructed and securely clamped to the table saw the cutting process can begin. Steel blades can be used, but using a masonry or steel abrasive cut-off wheel may reduce chatter on the PVC when cutting and give a better surface to work with later. A vacuum system attached to the table saw will help reduce the amount of PVC dust flying around. This dust can be fine unlike saw dust from a metal blade, and may build up on the table saw.

Figure 3. A simple jig to assist in cutting silo sections clamped to a table saw.

It would be wise to use a pair of protective eyewear, a respirator and possibly ear plugs.

The duct pipe must be supported at the opposite end to maintain contact with the jig fence, keep the pipe horizontal, and to turn the entire pipe (Figure 4).

Figure 4. Keeping the pipe supported and level while cutting is very important.

It is most helpful to have an adjustable height ball bearing roller stand and someone at the other end of the pipe to turn the pipe while it is being cut on the jig (Figure 5). One person will help turn the pipe and keep it flush with the jig fence. It is very important to be most vigilant during the cutting of the last few inches since the pipe can drop down and get "extra" cuts from the blade and damage the clean end of the silo. This is definitely not a one person job!

Figure 5. Sections are cut with the jig to make silos from the full length of pipe.

It is a good idea to cut each silo longer than the desired length by about 1 1/2 to 2 inches. After all the initial cuts are made, each cylinder of pipe can be put back onto the jig, the fence will be moved to within a couple inches of the saw blade and the ring which will be needed to hold the mesh on the silo can be cut off (Figure 6).

Figure 6. Cutting the ring to hold the mesh onto the silo.

Again, during the cutting of the last couple inches, it is very important to maintain control of the silo and the ring. These both need to have a clean level surface for adding on the mesh later.

Cutting the support holes and connector hole

Each silo will connect to either the side of the tank or a sluice in the center of the tank. Therefore some mechanism is needed to support the silo off the bottom and have it link to the tank side or sluice. The easiest way to do this is to support the silo with thin (1/2 inch) PVC or bamboo sticks that would rest on both sides of the tank, or the sluice box and one side of the tank. The connector will be below that on the silo (Figure 7).

Figure 7. Sticks that hold the silo in place in the upweller.

There will need to be four holes near the top of the silo through which the sticks will be placed, and one hole for the sluice connector. All these holes will be cut with a 2 3/8-inch hole saw mounted in a sturdy drill. To make this more efficient, a jig for this process can be made.

To construct the jig, take one piece of the original pipe (you have probably screwed one up really badly already). It only needs to be about a foot in length. Run it on the table saw or cut with a jig saw to open it up so that it can wrap around the remaining silo blanks (Figure 8).

Four pilot holes should be drilled on the jig about 2 1/2 inches from the top of the pipe for holes that the sticks will go through (Figure 9). These pilot holes

Figure 8. The jig for placing support holes and the connector hole on the silo.

Figure 9. Using the jig to position the holes on the sides of the silo.

should be spaced around the pipe. If one were to think of the hour hand on a watch face, the pilot holes could go at 1:30. 4:30, 7:30 and 10:30. Do not cut a large hole on the jig there, just a pilot hole!

The next pilot hole will be the one for the connector. It may be easier to cut the support holes first, hang the silo in the tank and scribe the hole's position with a marker from the other side of the connection (or if you haven't constructed the sluice, the process can be reversed using the silo connection to situate the sluice connection). Find the center of that hole, and drill a pilot hole on the jig. Make sure to keep the jig properly lined up with the end of the pipe. The jig itself should only have 5 pilot holes, no large bore holes, so it can be used on the rest of the blank silos. Once all the pilot holes are marked, cut out the connector hole with the hole saw on the pipe blank (Figure 10).

Figure 10. Using the hole saw to cut out the support holes and the connector hole.

This use of the 2 3/8-inch hole saw was designed so that, if you are going to use a 2-inch connection to the sluice/tank side, a 2-part screw-together connector will fit perfectly through the hole and can be screwed together. This will give much more strength to the connector itself. Don't glue in the connector yet.

By using the thin PVC pipes for support, one has some wiggle room with the lining up of the holes with the sluice. This can be accomplished by picking the right sized pipe, but if necessary, a piece of the pipe can be split at the ends so that a flat side will lay on the sluice or the side of the tank, allowing for some slight miscalculations.

Adding the mesh

Once the basic form of the silo is made, the next step is to add the mesh upon which the clam or oyster seed will sit. For simplicity, we will focus on making a silo with 1mm mesh. That is about the size of window screen, but it is not recommended to use that hardware store material, but to purchase engineered mesh which is uniform in size, has UV protection and is tough enough to stand up to much use. If a silo is being constructed for seed that is still in the earlier stages of a nursery system, and smaller mesh is being used, this process will be the same. Please note that 1mm mesh can come in various thread sizes. Purchase the mesh with the thinner thread size; the larger thread size, although the holes are the same size, is much too thick to work with easily.

The basic concept of this step is to hold the mesh onto the cylinder, then attach a ring to keep it in place tightly (Figure 11).

Figure 11. Laying the mesh onto the silo before clamping.

Once a piece of mesh is cut out, it should hang over the end of the silo cylinder opposite of where the support stick holes were cut. Allow about 5 inches of extra fabric out from the cylinder, so that the large hose clamps can be set down from the edge for clamping. This will now actually be the bottom of the finished silo. Once draped over, the fabricator needs to secure it in place so that the ring can be added. This is done with very large hose clams. Since these will last for years, it is a good idea to get large clamps. They cannot be found in a normal hardware store, but if you have purchased 16-inch PVC pipe from some supplier, they will likely be a well stocked plumbing supply house and have this size hose clamp (Figure 12).

It would be wise to get enough hose clamps to be able to work on at least 4 silos at once. One may have to link a couple of these hose clamps together to get all the way around a 16-inch pipe. The actual circumference of a 16-inch pipe is about 50 inches, so the clamps should be a few inches longer than that so that they can be tightened around the pipe and mesh. The hose clamps should be fitted about 3 to 4 inches below the rim of the pipe to leave enough room to glue on the PVC ring which will hold the mesh in place from here on. If there are any jagged edges on the pipe, it would be a very good idea to take grinder or belt sander to it to make it as level as possible.

Once the mesh is on the pipe, and it is being held in place with hose clamps, the mesh should be tightened

Figure 12, Hose clamps hold the mesh for the next step, gluing on the ring.

down by pulling on the mesh and drawing it down all around the pipe. The hose clamps can be tightened to keep the mesh in place. The mesh is fitted correctly when there are no bumps on the surface that will hold the shellfish, and when tapped, it sounds like a drum.

The PVC rings that were cut earlier are the same size as the pipe, and so obviously won't fit in their current state on the pipe (Figure 13). However, a few minutes in a 350°F oven will soften them up and make them pliable enough so that they can be stretched over the pipe. Putting the rings on a large sheet pan or lining the oven rack with some aluminum foil is a good idea. (It is also a good idea not to have one's spouse at home if you are doing this in the kitchen.) A very good exhaust fan or open windows with a good breeze will also be most helpful, unless you have an oven in your workspace. A drop cloth on the floor is a must for the gluing part of the process, which will be the cause of the odors.

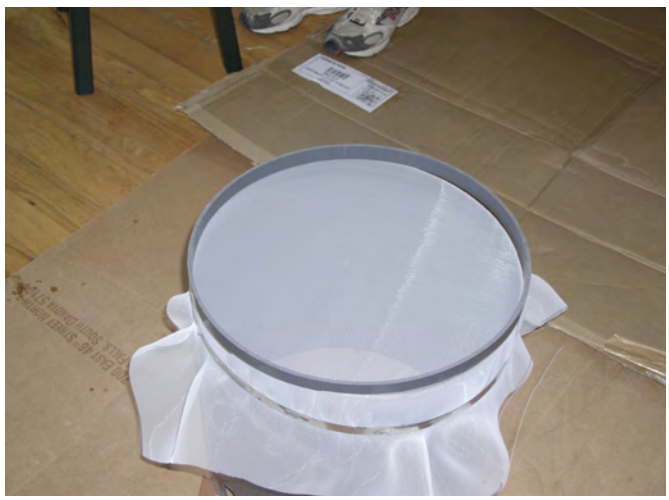

Figure 13. Rings must be softened in the oven to stretch them onto the silos.

As the ring warms and is almost pliable enough to work with (with gloves on!), a thick PVC glue should be applied to the mesh and pipe at the rim of the silo (Figure 14). Do not use the typical thin PVC glue, it will not have sufficient holding power. This will get messy, so the need for the drop cloth. This will also require having someone else help with this process, especially to turn the pipe around while one applies the glue (Figure 15).

Figure 14. Thick PVC glue works best.

Figure 15. Apply PVC glue liberally.

Once the glue has been added to the mesh, the ring should quickly be removed from the oven and stretched by both people over the top of the rim (Figure 16). It should be placed so that it is flush with the rim of the cylinder. The glue will harden sufficiently within a few minutes, and after that a bead of glue can be drizzled in the gap between the two sections of pipe at the rim.

Once hardened, the extra mesh, still being held on by the hose clamps, can be cut off with a razor knife

Figure 16. Stretch the warmed ring onto the glued area of the silo and allow it to set up and dry.

and another bead of glue can be added at the other edge of the ring connection (Figure 17).

The final step

Once the PVC glue has had a good chance to harden, the last part of the process is to add the PVC connector to the side of the silo. Using a two-part screw-together PVC connector, add some glue to the rim of the hole, and then screw it together through the pre-drilled hole (Figure 18).

The silo is now complete and ready for use. One caveat is that when storing silos on the ground, it is

Figure 17. The excess mesh is trimmed and the hose clamp is removed.

Figure 18. The connector is glued in place.

Figure 19. An alternative style of upweller silo (shown upside down).

much better to not put the mesh side down since something could puncture the mesh which would either require a patching job, or a complete resurfacing. It is also possible to cut the retaining bands wider and leave them "proud" of the edge of the silo by a 1/4 to 1/2 inch, to protect the mesh if it were put down that way.

It is also a good idea to write the mesh size that was installed on the mesh itself or on the side of the silo in indelible marker. This is especially important in the early nursery where hatchery personnel are sieving and grading growing post-set and putting them on larger and larger micron mesh.

Some commercial operators make the bottom band that holds the mesh onto the silo into legs by cutting the band, which is much wider than the ones mentioned here, with a jigsaw to make three legs, like a three-legged stool, so it won't rock on the bottom of the tank. The legs support the silo on the tank bottom, and protect the mesh during storage. With this technique, there is only one hole to drill and no sticks to store (Figure 19).

For those who might want a larger mesh on the silo, one can glue on the PVC band onto the end of the cylinder, then use a heavy duty caulk, like 3M 5200 to glue on a larger mesh, either cut from an oyster bag or purchased in a stock size. About 6 small stainless steel screws will ensure superior holding, just in case of too much weight as the shellfish grow. The excess heavy mesh can be cut off flush with a knife or melted off with a soldering iron with a rope cutting blade on it.

Properly constructed and maintained, upweller silos can last years and hold hundreds of thousands of shellfish seed on their way to field growout.

Sources of engineered mesh for silos

AREA: Aquaculture
Research/Environmental Associates, Inc.
P.O. Box 901303
Homestead, Florida 33090-1303
Phone: (305) 248-4205
http://www.areainc.com

Sefar Filtration

111 Calumet Street
Depew, NY 14043-3734
Phone: (716) 683-4050

http://www.sefar.us

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