Build Your Own Aquarium Foam Fractionator

How to build a foam fractionator for your aquarium.

Text and Diagram by Larry Jackson

In the fall 1994 issue of Aquarium Frontiers I wrote an article detailing the construction of a PVC foam fractionator that I thought was exceptionally easy to construct and practical for those hobbyists who like to build some of their own equipment. Since that time, I've made a few minor modifications to that design and then came up with an entirely new design and construction method that I feel many would be interested in. The single item I located that convinced me to redesign the unit was clear acrylic tubing. I like being able to see inside the column of my foam fractionators because this allows you to actually observe whether the unit is operating well. For a foam fractionator to operate efficiently, the water column needs to be filled with tiny air bubbles. An experienced aquarist can probably determine this by simply looking at the foam being produced, but the performance or any problem is more immediately known with the water column clearly visible.

The new design incorporates a 4-inch column, but, more importantly, a 4-inch foam throat that produces a very dry foam. On his web page, where the original design also appeared, Charles Delbeek suggested that a larger foam throat would be a possible improvement, and this was a another stimulus for me to rethink the material and construction.

This design is self leveling and requires no adjustment after a few basic determinations in the beginning of its use. A modification I made to the old design gave the tall, slender unit better standing stability. A similar feature has been incorporated into the design of this unit. Though more expensive than the first design, this unit is much more capable of removing dissolved organics in systems up to about 100 gallons. The unit can accommodate one or more air diffusers and, in systems greater than 50 gallons, I would encourage hobbyists to use two or more. The Tetra Luft seems to be the air pump of choice for applications where the water column height is as tall as in this foam fractionator.

I gravity feed surface-extracted water to my foam fractionators in all my systems, but it is certainly an option to pump water to the foam fractionator from the sump or a pump located elsewhere in the system. I prefer to minimize the use of pumps though, because they will break down and/or require service over time. For this reason I tend to use as little equipment as necessary to move water in my systems. Water movement is very important, particularly in reef aquaria, so don't think I am underproviding that crucial consideration. I try to size the main circulation pump of my systems to move about five system volumes per hour. I like to process as much of this flow as possible through the foam fractionator. This foam fractionator can handle flows of 500 gallons per hour.

One of the most commonly asked questions I receive by e-mail is how to incorporate a venturi into the design of the foam fractionator. While it is very possible to modify the design, I choose not to for my personal use. The use of counter-current, air diffuser units is a bit less technical and provides better air bubble size (smaller bubbles than most venturi), thus offering excellent organic removal. The new pinwheel foam fractionators I have seen in operation provide excellent results, but are not an option I have personal experience with.

All my foam fractionators sit in sumps. For this reason I have less concern about minor leakage or salt creep. I don't like salt creep, and do all I can to seal joints completely. If this unit is to be free-standing beside a sump, it will require great attention in assembly to seal all joints well. I'll detail this more in the assembly instructions. You would certainly want to water test the unit prior to operating it. If the foam fractionator sits outside a sump, the outflow plumbing design may require some modification.

Parts modification took about two hours and assembly another two hours. I have considerable experience building foam fractionators, so your construction time may be longer. Still, this is a very good device and one that many of you will want to construct. The cost of the parts may vary from one area of the country to another, and certainly depends on where you get them.

Check out the parts list below. Then I'll tell you how to modify the parts, what tools you'll need and how to assemble the unit. The description should allow you to get the correct part.

Parts List

1. 1 6-inch PVC DWV plug

2. 1 6-inch PVC female adapter
3. 1 6-inch x 4-inch PVC reducer bushing
4. 1 6-inch length of 4½-inch O.D. clear acrylic tubing
5. 1 4-inch PVC male adapter
6. 1 4-inch PVC female adapter
7. 1 1-inch length of 4½-inch O.D. clear acrylic tubing, another option is discussed in the modification and assembly instructions
8. 2 4-inch PVC reducing tee
9. 1 24-inch length of 4½-inch O.D. clear acrylic tubing
10. 2 4-inch PVC reducing tee
11. 1 This is a part removed from number 3
12. 1 4-inch PVC plug
13. 1 ¼-inch npt x ¼-inch barb nylon fitting
14. 1 1-inch x ¾-inch reducer bushing
15. 1 ¾-inch mpt x ¾-inch barb nylon fitting
16. 1 1-inch PVC 90-degree street ell
17. 1 27-inch length of 1-inch thin wall PVC pipe
18. 2 1-inch PVC 90-degree elbows
19. 1 1½-inch length of 1-inch thin wall PVC pipe
20. 1 1-inch PVC tee
21. 1 26-inch length of 1-inch thin wall PVC pipe
22. 1 1-inch PVC 90-degree elbow
23. 1 3- to 4-inch length of 1-inch thin wall PVC pipe
24. 1 3-foot length of 3/16-inch rigid air-line tubing
25. 1 ¾-inch of soft air-line tubing
26. 1 wooden air diffuser

Supplies Needed

Teflon tape

PVC pipe cleaner

PVC cement

Silicone sealant — see "Final Touches" later in this article before purchase

Tools*
Hacksaw with a sharp blade
Utility knife and/or sandpaper
Ruler or measuring tape
Marker
Rat-tail file
Flat file
Drill
3/16-inch drill bit
½-inch drill bit (see "Final Touches" section later in this article, for better tools)
Hammer
Wooden block
Disposable dropper (maybe)

*This is a minimum tool list. Other time-saving tools are noted in the section where I describe the modification of parts.

Parts Modification
Some of the modifications may seem pointless initally. Large diameter PVC is harder to glue together than smaller diameter pipe. My experience has been that the clear acrylic tubing fits PVC fitting sockets very snugly. There are several reason to shorten the sockets. By shortening the glue contact area it is easier to assemble the parts to the full length intended. This foam fractionator doesn't operate under significant pressure, so long glue lengths aren't needed. Secondly, shortening the glue sockets allows more clear acrylic to be left exposed, increasing the visual information of what goes on

inside the foam fractionator. Thirdly, reducing the glue sockets reduces the weight of several parts on the upper part of the foam fractionator, making it more stable.

I measure, determine where cuts are to be made and mark them on the outside surface of each part. I make the reference marks about an inch apart. I find that cutting a shallow reference groove on the outside of the part helps, but the reference marks may be enough. "Measure twice, cut once" is a good saying that I have found worth following.

Part 8 and part 10 are identical and can be modified in the same manner. Measure the depth of the glue socket and determine how much will need to be removed to leave a ½-inch-deep glue socket. I cut 1½ inches off each 4-inch diameter end of each tee. Carefully clean the cut ends with the utility knife or sandpaper.

Part 5 and part 6 have only one glue socket each. I cut 1¼ inch off each glue socket to leave the ½-inch-deep socket I like. Clean the cut ends.

Part 3 is part of the 6- x 4-inch reducer bushing purchased. Cut 1½ inches off the flanged end of the reducer bushing. This will be part 11. Further modification of part 3 is necessary. There is a pipe stop inside the 4-inch hole of the reducer bushing. This lip must be removed so that the clear acrylic tubing can pass completely through the reducer bushing. This makes an annular area inside the assembly of parts 2, 3 and 4 where the foam that is removed can collect. I'll refer to that liquified material as "skimmate." With the rat-tail file, remove the pipe stop, testing the hole with the clear acrylic tubing as you near completion. A snug fit is desirable, so test often near completion of this step. If you have a Dremel or similar tool, this is a real time saver. I wouldn't buy one just for this project. Clean the cut ends.

Part 2 has one glue socket. Shorten this socket so that the end of part 2 and part 3 will be even when assembled. I removed 1.375 inches. There is some variety in the design of reducer bushings, so measure and determine your appropriate modification. Clean the cut end.

Part 12 will seal the bottom of the foam fractionator column and is part of the base. In order to have a flat base, the hexagon end of this part must be modified so that it fits into part 11. Cut off the hexagonal parts of part 12 and use a file to shape the outside end surface to a round profile. This is another modification that can be more easily accomplished with a Dremel tool, a large disc sander or a bench grinder. Make sure that part 12 will fit into part 11 all the way so that a flat base can be achieved.

Part 12 requires additional attention. When glued in place, this part will protrude through the top of part 11. Measure and cut the length so that protrusion will be ½ inch. I cut ½ inch off the length to achieve this. Clean the cut end.

Parts 4, 7 and 9 are clear acrylic tubing. We need pieces of 6-inch, 1-inch and 24-inch lengths. Part 7 can be of 4-inch standard PVC. It is to join parts 6 and 8 and is totally hidden in the glue sockets of these two parts. If a short piece of 4-inch PVC can be obtained, use it to make part 7. Clean the ends.

Cut parts 17, 19, 21 and 23 to lengths of 27 inches, 1½ inches, 26 inches and 3 or 4 inches. These parts are of thin wall, 1-inch PVC pipe.

The only other modifications are holes, which I will detail near the end of the article in the "Final Touches" section.

Main Column Assembly
I like to begin assembly at the base of the unit. Part 12 needs to fit completely inside part 11 so that it extends above the top of part 11 by ½ inch. Test fit the parts together and if satisfied, clean the glue surfaces with PVC pipe cleaner and then use PVC cement to join them. Clean the glue surfaces of part 12 that protrude above part 11. Cement part 12 to part 10. This seals the bottom of the foam fractionator column.

Test fit part 9 into part 10. This is the tallest part of the foam fractionator, so try to get this part vertical. A level is handy if you have one. If the clear acrylic fits easily into the PVC socket, remove it, clean the glue surfaces and cement the parts together. Assembly gets a little more complicated if the fit is extremely tight.

Without cleaner or cement, fit part 9 into the socket of part 10. Use the wooden block and hammer to gently, but firmly, seat part 9 in the socket. After checking to see that part 9 is vertical, use some pipe cleaner at the joint of the two parts. When the cleaner has evaporated, use a disposable dropper or similar device to apply PVC cement around the joint to seal it well, particularly if the unit is to be located outside a sump or comparable container.

Before further assembly, orientation of the inlet and discharge fittings of the foam fractionator must be considered. I offset

these fittings 90 degrees to avoid clearance problems with water supply to the unit and the outflow plumbing. After determination of the orientation, proceed with assembly.

Part 8 will be joined to part 9 in the same way as parts 9 and 10 were joined. If you are using the hammer-together and fill method, it is easier to turn the unit upside down and fill the joint with cleaner and then cement.

Part 7 cements into part 8.

Part 6 cements to part 7.

Apply teflon tape to part 14 male threads and screw snugly into part 8.

Apply teflon tape to part 15 male threads and screw snugly into part 14.

Apply teflon tape to part 16 male threads and screw snugly into part 10 with the elbow opening pointing straight up.

This completes the assembly of the main column of the foam fractionator.

Scum Cup and Foam Throat Assembly

Part 4 cements to part 5.

Before you glue part 3 into part 2, be aware again that larger PVC fittings don't always go together easily. In field applications, sophisticated tools are used to align, force and hold fittings together because of the difficulty of assembly. The hammer and wooden block may be necessary to seat part 3 into part 2 completely. Clean the glue surfaces, coat them with PVC cement and put part 3 into part 2. If needed, quickly place the wooden block on the edge of part 3 and use the hammer and rapid movement of the block around the circumference of part 3 to drive it all the way to the pipe stop in part 2.

Whew! Almost finished with the hard steps of construction!

Fit part 4 into part 3. The upper edge of part 4 should be 1 inch below the top edge of part 2. This gives room for the foam to spill over into the annular collection area. Make a mark on part 4 showing where it should align with the bottom of part 3. Take part 4 out of part 3. Clean the inside glue surface of part 3. Put part 4 back into part 3 to the mark. Pull part 4 back about 1 inch and clean that 1 inch of clear acrylic with PVC pipe cleaner. Coat the same area with PVC cement and push part 4 into part 3 to the mark (assuming you didn't erase the mark with the cleaner). Let the cement dry.

If the fit between part 3 and part 4 is really tight, you may use the clean and fill method used for other acrylic tubing to PVC joints.

In order to prevent skimmate from leaking out of the collector cup made of parts 2, 3 and 4, we will seal the joint of parts 3 and 4 a bit more. Using the disposable dropper or similar device, liberally add some additional cement to the inside junction of parts 3 and 4. Set the scum cup and foam throat assembly aside to dry well.

Self-Leveling Outflow Assembly
Cement parts 18, 19 and 20 together. Select the sides of parts 18 and 20 that have no mold marks and place them down on a flat surface. When you cement the parts together using part 19, forcing them flat on a level surface will align them

Cement part 17 into part 18.

Cement part 21 into part 20.

I do not cement part 22 to 21 or part 23 into part 20. Part 22 can be turned so the discharge of water into the sump is directed so there is less splash or goes in a desirable direction if left with a friction fit only. Part 23 is an extender to part 20 that prevents saltwater from splashing out of the top of the tee. A plug of filter fiber can be put into the upper end of part 23 to muffle sound a bit and to further reduce splash from escaping.

Final Touches
There is a need to drill a couple of holes. First, drill a 3/16-inch hole in the center of part 1. This is where the air diffuser connections will enter the foam fractionator. If this unit is to be used on systems of greater than 50 gallons, I would

suggest two or more diffusers. This will require additional holes in part 1, but start with one hole.

Part 13 has to be installed. The unit needs an air vent and the ability to get excess skimmate out of the collection cup. This can be accomplished with part 13 installed in the scum cup. The hole for part 13 needs to be lower than the top of part 4 inside the collection cup, but not so low that it cuts through too much of the upper lip of part 3. I drill through the outside of part 2 on the upper part of the ridge that corresponds roughly with the pipe lip inside the scum cup. If you have a ¼-inch NPT tap, drill a 7/16-inch hole and tap threads into it. Wrap teflon tape onto the male threads of part 13 and screw it into the hole, leaving the discharge barb pointed down. If you don't have access to a tap, drill a ½-inch hole instead. Cover the threads of part 13 with silicone sealant and force it into the ½-inch hole, with the barb pointed down.

Final Assembly
Wash all parts to get rid of debris, solvents and dirt. Screw the scum cup and foam throat assembly to the main column assembly (part 5 screws into part 6). To seal this joint better and to make disassembly and cleaning easier, use teflon tape on the threads of part 5.

Join parts 24, 25 and 26 together. Push a few inches of part 24 up through the bottom of part 1, lower the air diffuser into the the top of the assembled unit and screw the lid (part 1) in several threads. This doesn't have to be tight or completely screwed in.

Fit the self-leveling outflow assembly into part 16 in an orientation that fits the sump or installation. If the foam fractionator is to sit outside a sump, cementing part 17 into part 16 will be required eventually. I suggest putting a container under the foam fractionator to catch leakage while the next step is done. When a final configuration of the outflow assembly is determined, cement it in place.

Adjusting the Self-Leveling Outflow Assembly
After the foam fractionator is working in the system, you will need to make sure that the water/foam interface in the throat (part 4) is at a level appropriate to your water flow and air input to the unit. I operate my foam fractionators with lots of air input and keep the water/foam interface lower because my foam stacks up rather tall. You can push too much air through an air diffuser and cause the bubble size to increase dramatically. Try and see what the effect is! Push as much air through as possible while keeping the bubble size small. Use of more than one diffuser will allow more air to be injected, while keeping the bubble size small. I would suggest that the water/foam interface be nearer part 5 if you are adding lots of air. If your air source is weak, the water/foam interface needs to be nearer part 3. If you are adding lots of air and the water/foam point is near part 3, you may need to shorten part 17.

Another consideration is the discharge of water through part 22. I like to discharge water at the surface of the sump. If water is discharged too high, it splashes more than I like. If discharged below water level, burping or other noises are noted. Shorten part 21 based on sump water level, and after the length of part 17 has been determined.