inland building what we'd like to own.

Drilling Holes in Aquariums

How to Drill for Bulkhead Fittings Using Diamond Hole Saws

Drilling holes in any glass reduces the structural integrity of the glass and will reduce the safety levels that were intentionally engineered into your aquarium. In offering these tips and techniques, we do not accept any liability and disclaim any expressed or implied warranties and all incidental or consequential damages should problems arise from using our products for drilling aquariums.

Drilling with any diamond drills is part science, part art, and some practice once you understand the basics:

1. **Selecting the Right Drill.**
1. **The Equipment You Will Need.**
1. **The Importance of Coolant.**
1. **Drilling Speed and Pressure.**

Safety First!

- Make sure that the glass you are drilling is **NOT TEMPERED**. **NEVER** drill into any glass unless you are certain it is **NOT** tempered. Tempered glass cannot be drilled using diamond hole saws;it can shatter on contact. If you are not sure about the tempering here are two of many ways to tell if the glass is tempered or not:
    1. Check the corners of the piece of glass. If the glass is tempered, it is required for the manufacturer to etch the four corners, identifying it as tempered or safety glass.
    2. View glass at an angle through a polarizing filter. The filter will expose black lines in the glass that occurred during the tempering process. These lines become more prominent at sharper angles.
- **It is extremely important to wear proper eye protection**. We highly recommend that you wear safety goggles rather than safety glasses.
- **DO NOT** wear loose clothing or any accessories (long necklaces, bracelets, shirts with long fringes, and similar) that might get caught in a power tool.
- Diamond tools require coolant, water being the most common, and electricity; so extreme care must be taken. Make sure machines are powered by a properly grounded and tested outlet. Under **NO** circumstances should you override the grounding system or modify the plug in any fashion.
- Read and understand the proper set-up and operation of your machinery.
- Set up so you are drilling on a sturdy, level surface at a comfortable height on which to work.

Selecting the Right Drill

Drilling hole sizes common for bulkhead fittings in glass requires a diamond hole saw. The diamond can be electroplated, sintered, or brazed to the base metal depending on its intended use and desired cost vs. life. For drilling a hole or two, an electroplated drill is a good choice. If you plan on drilling numerous holes then using a brazed hole saw is the cost effective choice. Brazed hole saws cost a little more but last a lot longer and will drill more holes than their plated counterparts. Sintered drills can last even longer but will cut slower. They are more suited to industrial purposes.

Be sure you have the right sized drill bit: Pipe is measured as an inside diameter. So 1-½" pipe or a 1-½" fitting will have an 'inside diameter' of 1-1/2". However, the outside diameter can vary depending upon the type of pipe or fitting used and depending upon the specific manufacturer. Be sure to measure the outside diameter properly so that you drill the correct size hole. This sounds basic but it is a common mistake.

The Equipment You Will Need

You need a drill that will properly hold and secure the hole saw and allow you to control drilling speed through the process. A hand held variable speed drill will work but for hole saws a variable speed drill press is highly recommended, especially when using hole saws 1/2" and larger; it is very difficult to properly control the drill and material when using a hand held drill.

The Importance of Coolant

The surefire way to destroy a diamond drill is to run it dry or without adequate coolant. Coolant is required to cool the hole saw and flush out the debris (called swarf) generated during drilling. Water is the most frequently used coolant. It provides excellent performance at a minimal cost and is a true organic coolant. It doesn't leave an oily or greasy residue on the material. There are additives, like Inland DiamondCoolant, you can add to the water to help increase the lubricity and protect your diamond tool investment:

- Adequate coolant increases the diamond drill efficiency and reduces heat buildup, thereby reducing the chance of heat cracking the drilled material.
- Adequate coolant will help flush away swarf and insure proper lubrication of the drill. Using an up and down motion while drilling keeps fresh coolant flowing into the drilling area.
- Sparks (or a dry, crumbly residue) while drilling indicates insufficient coolant is reaching the drilling area and you risk cracking your aquarium and damaging your diamond hole saw.

The most straightforward way to supply coolant when drilling in an aquarium is the **Clay Dam Method**. A dam is built from inexpensive modeling clay around where the hole will be drilled, about 1" larger than the finished hole size and about ½" high. The dam is then filled with coolant. This ensures adequate coolant is supplied while drilling. Suction base drill rings are also available and can be used in a similar manner.

Drilling Speed and Pressure

Drilling speeds are affected by the hardness and abrasiveness of the material, the size of the drill, the amount of pressure, and coolant used. The speeds listed below are suggested guidelines but only experience will help you develop the right drilling speed and pressure for your application.

General Guidelines

- A general rule of thumb for diamond coated tools is the harder the material, the faster the drill speed.
- Set the torque to #1 (if you can) on your hand drill. That way, if it "sticks" the motor spins but not the drill. This can save you from cracking or breaking through inappropriately.
- Beginners should start with low pressure and extra coolant to prevent damage to the diamond while learning.
- Use light pressure and let the diamond do the work. Unlike twist drills, diamond tools require only light to moderate pressure for optimum results. Allow the bit to grind at its own speed. Too much pressure can fracture your tank and prematurely wear the diamond.
- Use an up and down motion when drilling to allow coolant to circulate in the hole and flush out swarf and allow fresh water / coolant to penetrate the hole. This is especially important when drilling through thick materials.
- When drilling completely through an object, really lighten up the pressure as the drill is about to break through the bottom so that you don't chip out the back side as it emerges. Let the force of gravity be the only pressure on the final cut.

Drilling Speed Chart

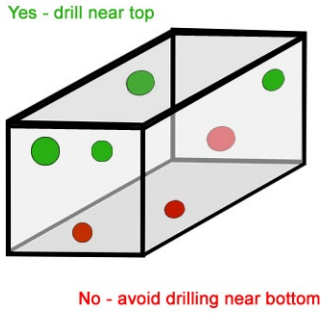
WIRE DRILLS	HOLE SAWS AND SIMILAR BY OUTSIDE DIAMETER			
.75 – 2.5 mm	1/8 to 1/2 inch	5/8 to 1-1/2 inch	1-3/4 to 2-3/4 inch	3 to 4 inch
30,000 TO 18,000 rpm	2,400-1,000 rpm	1,250 – 1,000 rpm	1,100 – 850 rpm	850 to 200 rpm

Drilling a Hole

1. Determine the location of the hole and mark with a permanent marker.
2. Cover the back side of the hole with masking or painters tape to help reduce breakout and chipping as the hole saw comes through the back side. Use plenty of tape so the "plug" of glass doesn't fall and break the opposite wall.
3. Use the clay dam method to make a dam around the hole to be cut.
4. Place a towel under the hole so the cut glass plug won't drop onto the opposite glass side. A towel will also help absorb the coolant that will follow the plug out the newly drilled hole!
5. Fill the dam with coolant. Add additional coolant if needed during drilling.
6. Drill the hole following the guidelines outlined earlier. Remember light to moderate pressure and let the diamond do the cutting. Use an up and down motion during drilling to allow coolant to circulate in the hole and flush out swarf.
7. Really lighten up the pressure as the drill is about to break through the back side. If it takes you 3 minutes to drill 75% of the way through, back off and use another 3 minutes to go most of the remaining 25%. The final 1/32" to 1/16" is the most delicate so really take your time and ease up on the pressure.
8. Use a small piece of fine sandpaper to dress the hole to avoid stress cracks.
9. Wash the tank out by rinsing thoroughly to remove any residue; avoid rubbing or scrubbing, that residue is ground glass that can scratch!

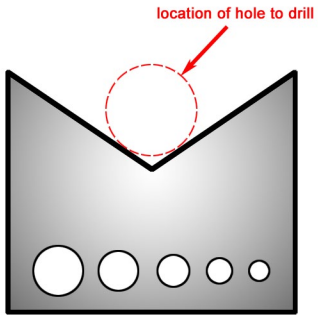
General Tips for Better Aquarium Drilling

- Avoid drilling in the bottom of the tank, it is often tempered glass. Additionally, the water weight on the bottom is significantly higher than on the sides of a tank. Micro fractures always occur anytime glass is cut or drilled, and the hole reduces the structural strength of the glass. While aquariums are generally engineered to be much stronger than actually needed for their capacity, the bottom is the "weakest link" and is best avoided.
- Drill at least 1" from the edges or corners of the glass: All glass contains minor imperfections and flaws and again, micro fractures occur along the edge of glass when it is cut. To avoid placing any additional stress on these weak spots, try staying at least 1" away from any glass edge.
- The force of the water against the glass is greater at the bottom of the tank than at the top. Try to make all drilled holes near the top of the glass sides where less pressure is exerted.



- If a white powder forms as you drill, stop! Remove the drill, clean and add more water/coolant. NEVER USE DIAMOND DRILLS DRY TO DRILL GLASS!
- For optimum results, bring the drill down at a right angle to the hole and keep it perpendicular through the entire drilling process.
- Use a light pressure while drilling until you become familiar with your drill's cutting speed. The weight of the drill itself should provide sufficient cutting pressure. You want to allow the diamond to do the cutting! Too much pressure can fracture the material and prematurely wear the diamond.
- Frequently remove the hole saw from the hole during drilling to flush out the ground material and allow fresh water / coolant to penetrate hole. Also rinse accumulated material from the hole saw itself.
- You must remove any slugs from the inside diameter of the hole saw. Remove by pushing a nail or stout piece of wire through the hole provided in the side, or on larger hole saws, through the back.
- If you are using small (less than ½" diameter) hole saws in a hand drill, start drilling with the saw held at a 45° angle to the material. As drilling proceeds and the diamond edge begins to bite into the material, slowly bring the drill to a vertical position until you are drilling at a right angle to the material.
- In addition to using the #1 torque setting (if you have the option) of the drill, You can prevent "walking" when starting a hole by:

Making a Drilling Template



1. Make a template by either drilling a pilot hole in a piece of 1/8" plastic, 1/8" pressed wood or cardboard, or by cutting a "V" in the edge. A hole template works best, however, the "V" template is easier to make and can be used with many sizes of hole saws.
2. The template is held on the surface of the material being drilled, with the pilot hole or "V" above the target hole area and will hold the drill bit in place as it starts.
3. A few revolutions of the drill will create a shallow hole, or groove if using a hole saw, that will now hold the drill in place and the template can be removed if desired.
4. Consider making a plastic (like Plexiglas) template if you plan on a lot of drilling; it will hold up the longest to water and wear.

Making a Temporary Drilling Foothold

1. Mark the center of the hole using an easy to see indelible pen.
2. Layer several pieces of clear tape over the mark until you build up a "pad". If needed, re-mark the hole location on the tape if the original mark becomes obscured through the layers.
3. The layered tape pieces will give the bit a place to bite into as you start the hole and are easy to remove.
4. Similarly you can use a piece of masking or duct tape over the area and then mark the hole location but this may not be precise enough for some applications.
5. Use a glass or stone scribe to create a small round divot or scratch where you want to drill to give the bit a place to bite as you start drilling the hole.

This free how to is courtesy of

inland HOBBY

Inland Craft Products, Co.

32052 Edward Drive
Madison Heights MI 48071
(248) 583-7150

www.inlandhobby.com
www.inlandcraft.com