Arrow Springs

Tips and Tricks

FROM THE STAFF OF

Arrow Springs

THANK YOU FOR YOUR PATRONAGE

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If you ever have questions about using any of our tools or supplies, just give us a call and we'll be happy to answer them.

Connecting Pressure Regulators

Improper installation and use of pressure regulators can be dangerous and may cause damage to the regulators. Proper installation and use of pressure regulators and tanks is safe. Before connecting pressure regulators to their respective tanks, position the tanks in a safe location away from flame and out of walk ways. The fuel tank, usually propane, must be in its upright position sitting on its intended bottom. Fuel gas is usually pressurized to a liquid, as is propane, butane and MAPP gas. The tank valve must be positioned above the liquid, in the gas, for the pressure regulator to work properly. The oxygen tank can be positioned in any position. It is usually best to stand it up. Before removing any safety caps, secure the tanks to a wall or the work bench, if it is stable enough to give proper support.

Remove the caps from the tanks and connect the pressure regulators. Connect the torch to the output side of the pressure regulators with proper hoses. Propane, butane or MAPP gas must only be used with a Grade T hose. Regular welding type Grade R or Grade RM hose, which is fine for acetylene, will rot with propane, butane or MAPP gas. Do not use acetylene as a fuel gas. It does not work well with glass and lampworking torches are not designed to use it. Be sure that there is not any oil, grease or debris in or around the tank valves, hoses or on any part of the pressure regulators. Grease and oil are explosive in the presence of oxygen. Debris on the fittings will not allow for a proper air tight seal. The thread pattern on the oxygen tank valve is right handed. The thread pattern on the fuel tank is left handed. Left handed threads are indicated by a notch around the fastening nut on the pressure regulator and the hose fittings. The fittings on both pressure regulators and the hoses are flair type fittings and only require moderate tightening. All fittings are made of brass and are easily destroyed if the wrong tools are used to tighten them. Only use the proper size open end wrenches or quality adjustable jaw (Crescent style) wrenches. Vise Grips or Channel Lock style wrenches will quickly destroy the fittings and will not tighten them properly. It is not necessary to use a thread sealer and should not be used as it can actually cause a leak if it gets into the seat area of the connection. Test for leaks with soapy water.

Before opening the tank valves it is important that the pressure adjusting handles are backed off to a zero pressure delivery. This is done by turning the handle counterclockwise until the resistance of the handle turning becomes easy. It is alright if the handle comes off the pressure regulator. Just screw it back on one full turn. If the pressure adjusting handle is not backed off when the tank valve is opened, the fast inrush of gas may damage the diaphragm inside the pressure regulator. Check that all torches connected to the regulators are off. Before opening the tank valve, stand next to the tank, positioning the tank valve between you and the pressure regulator. If the pressure regulator is damaged it may blow off the tank when the tank valve is opened. Standing behind the tank valve is the safest location. The oxygen cylinder is under high pressure and uses a special double seat valve. The valve only seats air tight when it is fully closed or fully open. Any position in-between may slowly leak oxygen from around the valve stem. Open the oxygen tank valve slowly for the first turn, then fully and firmly. The fuel tank is usually under much less pressure and uses a different kind of valve. Open this valve slowly for the first turn, then only to one or two turns. This makes it faster and easier to turn off the propane tank's valve in an emergency situation. Turn the pressure adjusting knob clockwise to allow gas to pass through the pressure regulator. The more the handle is turned, the greater the delivery pressure will be. The pressure gauge closest to the tank valve indicates the tank pressure. The other pressure gauge indicates delivery pressure to the torch. To reduce delivery pressure, turn the adjusting knob counterclockwise. The delivery pressure gauge will not indicate a lower pressure until the pressure is relieved on the output side of the pressure regulator. You can do this by having the torch running while turning the handle counter clockwise. To shut down the system, close the tank valves, burn off the pressurized gas in both gas lines by lighting the touch. As the flame goes out turn off the torch, back off the pressure adjusting handles as described earlier.

The best pressure to use for the health of the regulators is between 20 and 25 pounds for the oxygen and 10 to 15 pounds for the fuel gas. Using these pressure settings will keep the pressure regulators performing better and have a longer life. However, some glasses are hyper sensitive to flame chemistry and can show signs of reducing at these higher than necessary pressures. In this case you may want to choose different pressure settings that are likely lower. Every torch has its own optimum pressure settings. Many torches give suggested pressure settings that are lower than what is stated here. These pressures are listed as a range with the lower pressure being the minimum to establish a proper flame and the higher pressure being the most the torch needs to obtain the largest proper flame it can produce. The lower pressure is typically so low that it usually produces so small a flame as to be unsatisfactory for lampworking. Supplying higher pressure does not increase gas consumption. The actual oxygen and fuel gas consumption that the torch operates on is what you manually set using the torch's valves. Some propane pressure regulators have a red danger zone on the delivery pressure gauge. This only applies when the pressure regulator is used with acetylene. Disregard it when using propane, butane or MAPP gas.

Arrow Springs

Installing and Using Oxygen Mix Torches

Only use the appropriate diameter Grade T hoses to connect your torch to its oxygen and fuel supply. Technically, a torch is hand held and a burner is table mounted. However, burners are most often referred to as torches. Regular welding type Grade R or Grade RM hose, which is fine for acetylene, will rot with propane, butane or MAPP gas. Some lampworking torches connect to hoses with hose barbs and hose clamps. Most torches now use the same “B” size screw-on fittings to connect the hoses to the torch that is at the other end of the hoses, which connect to the pressure regulator.

For torches with screw-on connections, simply screw together the fittings of the torch to the fittings of the hose using appropriate open end wrenches. One wench is used on the “B” size nut of the hose (usually 11/16”) and one wrench is at the base of the “B” size fitting on the torch. The green oxygen hose uses regular right hand threads. The red fuel gas hose uses left hand threads.

For torches that use hose barbs to connect the hoses, split the two hoses apart to about 8” (20 cm) from their cut end. The red fuel gas hose connects to the hose barb that leads to the torch’s red gas valve. The green oxygen hose connects to the hose barb that leads to the fuel gas valve which will be either silver or green. Before putting the hoses onto the hose barbs, loosely slip the hose clamps over the ends of the hoses. Have the screw of the hose clamp orientate so that it does not sit near the torch’s gas valve after tightening. This is so your fingers do not bump into them. Push the hoses onto the hose barbs at least three quarters of the way, if not all the way on. Slide one of the hose clamps over the area of the hose that covers the hose barb and center it over the barb. Tighten the clamp only enough to slightly bulge the hose, but not cut into it. Do the same to the other hose clamp. If the hose is difficult to push over the torch’s hose barbs, wet them with water only. NEVER use grease or oil anywhere near oxygen. This combination is always explosive. If the hoses are reversed, the torch will not work properly.

Lampworking torches are typically used with oxygen and either propane or natural gas. To use hydrogen usually requires a special torch. MAPP gas is not recommended. Acetylene will not work with glass and will destroy most lampworking torches.

Connect hoses to properly installed pressure regulators. See our instruction sheet for proper pressure regulator installation and recommended pressures.

Typical oxygen consumption for most bead scale torches is 9 to 11 standard cubic feet (scf) per hour (260 to 320 liters per hour - lph). Propane usage is approximately 1 gallon per 250 scf of oxygen.

To adjust the flame properly: Using a flint striker, light the torch with only a small amount of fuel gas on. Both the red fuel hose and the green oxygen hose will have air in them until they have been purged. These hoses are purged by simply allowing the gases to flow through them. This only takes a few seconds. However, until the hoses are purged, lighting and maintaining a flame is difficult. Start by making the fuel gas flame only about 8” or 9” long (20 to 22 cm) (about as long as a hand span), then add oxygen. Adjust the oxygen until the flame has a small, crisp looking inner dark blue flame with its very tip ever so slightly fuzzy and maybe a hint of yellow. This inner blue flame will be about 1/4” to 3/8” (6 to 8 mm) long on most surface mix lampworking torches. For a normally used neutral flame, the general shape of the whole flame is rather straight. If the tip of the inner dark blue flame is very fuzzy and the general shape of the whole flame is slightly barrel shaped, you have a reduction flame, and while this is sometimes a desirable flame, you will find that some colors will reduce to grays or some other unexpected color. Increase the amount of oxygen or decrease the amount of propane to make a neutral flame. If the tip of the blue flame is extremely sharp and well defined, the torch starts to make a whistling sound and the overall shape of the flame is needle like, you likely have an oxidation flame. Increase the amount of propane or reduce the amount of oxygen to make a neutral flame. The life of the torch will be greatly shortened if the flame is too weak. A weak flame is one that doesn't have enough force behind it to make it burn straight. It curves upward. This causes the face of the torch to overheat and erode.

If you find that you need more heat, try working in the flame closer to the torch where the flame is hotter or adjust the gases to make the flame proportionately larger. You will find that a larger flame will give you more overall heat and that further out in the flame you are less likely to boil the glass, because the temperature is lower. If the flame becomes distorted, you probably have it set too high.

If you find that the glass burns or bubbles or has "scum" on it (scum is usually micro bubbles), then you are most likely getting the glass too hot. This can be corrected by one or all of the following: Rotate the glass more to better distribute the heat throughout the glass, try working in the flame further from the torch where it is cooler or adjust the gases to make the flame proportionately smaller. Also, sharp edges of glass heat up faster and overheat, than smooth surfaces do, because it cannot dissipate heat as easily. These sharp edges can be a major source of scum. It is always a good idea to remove the end of a cut glass rod by melting it and pulling it off with tweezers.

A reduction flame is cooler than a neutral flame, although its radiant heat may feel hotter to you, and has a large bushy look to it. It can also be very dirty and may deposit soot on the glass as well as reduce it.

An oxidation flame is also cooler than a neutral flame to the glass. The overall flame can be adjusted to very short and needle like. This type of flame is sometimes used for working with stringers, because it has a jacket of cool, unburned oxygen around it that insulates the part of the stringer not directly in the flame from the heat, thereby giving you better control. Usually, the easiest way to adjust the torch for this type of flame from a neutral flame is to leave the oxygen setting as is and reduce the fuel setting. A neutral or reduction flame tends to make the stringer soft some distance from the flame quickly and you can soon lose control of it.

CLEANING

Torches require periodic cleaning. You can usually tell when cleaning is necessary. You will see a carbon build up on the face of the burner or sometimes the fuel ports on the burner face may look restricted. You may not notice the flame reacting differently until quite a lot of carbon build up has accumulated, but a small amount of build up can affect flame quality and shorten the life of the torch.

Most of the carbon that builds up on the burner face is most often caused or accelerated by using a flame that is too weak. Dirty propane can also be a cause. Different torches build up carbon at different rates. Excessive carbon build up on the burner face works as a heat conduit and will transfer the heat of the flame to the burner face, thereby overheating it. Overheating causes eroding and or swelling of the metals of the burner face. This not only shortens the life of the torch, but creates poor flame quality. Dirty fuel ports, when left unattended, may get so restricted that getting the cleaning tool into them can be very difficult.

ALWAYS turn off the torch and let it cool before cleaning or you might melt the cleaning tool to the burner face. Only use the provided cleaning tool or an approved torch cleaning tool.

Cleaning is very simple and quick. Most of the carbon build up on the burner face can usually just be brushed off with a sideways stroke of the cleaning tool. To clean the fuel ports, insert the wire end of the cleaning tool into the port a short distance. The wire is smaller than the hole. Work the wire in and out several times while rotating the wire in a circular or cone shaped motion. This breaks off the build up that accumulates at the very edge of the hole. Repeat on all the fuel ports. Typically the oxygen ports stay clean. You can clean them as necessary.

If you accidentally touch molten glass to the torch and it sticks, immediately turn off the torch. If you try to remove it while it is still molten you will only smear it over the burner face and into the ports. After the torch has cooled, carefully use the cleaning wire and chip away as much of the glass as you can and then clean as usual. Use caution to not damage the burner face. Molten glass is corrosive to metal, so be sure to remove as much as possible. If only a very small amount of glass is still on the burner face and all of the ports are not clogged, the glass will usually burn away within a few minutes.

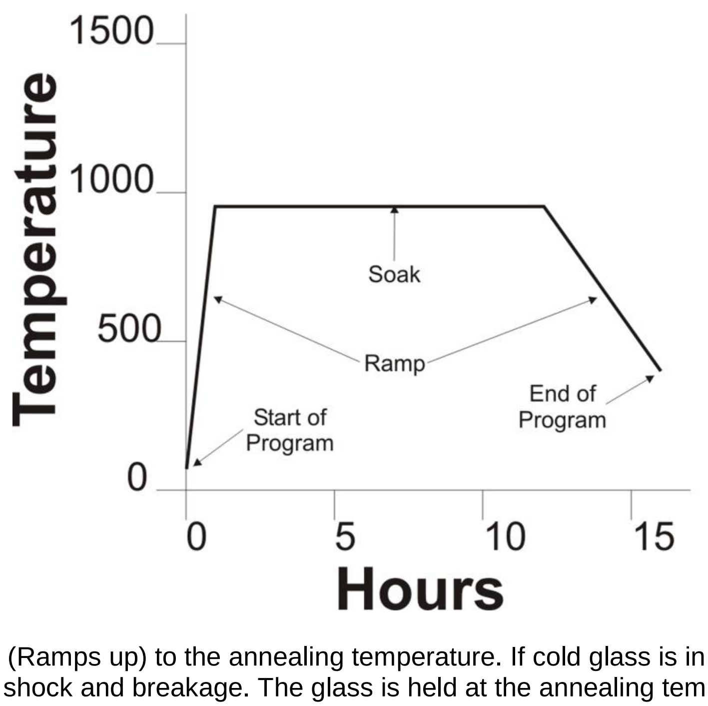
Arrow Springs

About Annealing

Unless glasswork is very small, it needs to be annealed after it has been melted to prevent it from breaking as it cools or shortly thereafter. Annealing is accomplished only by holding a steady temperature over a period of time. The temperature and time are determined by the type of glass and its size and shape. Lower COE glasses develop less stress than higher COE glasses for a given set of circumstances. The thickness of the glass has a large influence on the length of time needed to anneal and cool the glass. However, a larger piece with the same thickness also influences annealing hold time and cooling rate. Annealing can only remove stresses that develop during the manufacturing process. Annealing cannot remove stresses due to variations in COE of the different glasses used within the item.

There are several kinds of stresses in glass that can cause it to break. If any single stress is large enough, or a combination of stresses is large enough, a critical level is reached and the glass will break. Stress caused by differences in COE within the glass item cannot be annealed away, so you need to use glasses that are compatible within the glass item. This is not always easy when that special color you want to use has a COE different enough from the other glasses that it may cause the glass item to break if not otherwise nicely annealed. Given that you properly annealed the glass to remove manufacturing stress, and not considering thermal shock and impact shock, stress developed during cooling adds to the COE stress and can be all it takes to break the item. Cooling actually puts stresses back into the glass. Cooling slowly adds less stress than cooling at a faster rate. A lesser amount of cooling stress added to the COE stress may be all it takes to keep the glass below the stress threshold that would otherwise break it. As with the annealing portion of the annealing cycle, the cooling rate is determined by the type of glass and its size and shape.

Ideally, successful annealing is done by placing just made glass items into a pre-heated annealer set at or a little cooler than annealing temperature, before the item cools much below the annealing temperature. This helps prevent the item from breaking before it has had a chance to be annealed by eliminating the possibility of thermal shock and by the fact that while glass is very hot it is not as adversely affected by stresses. Essentially, it is best to remove the stress while the glass is hot, because the stresses in glass at lower temperatures can more easily break the glass.



The annealing oven heats (Ramps up) to the annealing temperature. If cold glass is in the annealer, the ramp rate up is slow to prevent thermal shock and breakage. The glass is held at the annealing temperature long enough for the manufacturing stress within the glass to be released (Soak). The glass is then cooled (Ramps down) at a slow enough ramp rate so as not to reintroduce too much stress back into the glass.

Arrow Springs

Using SLUDGE™ Mandrel Releases

SLUDGE™ mandrel releases give superior holding strength to the tugging and twisting rigors of even the most aggressive beadmaker, yet the bead easily twists off when it cools. Dip-n-Go SLUDGE™ is generally the recommended release because of its balance of superior holding power, ease of use, easy releasing of the bead when cool, smooth coating and it can be dried in the flame. Dip-n-Go Blue SLUDGE™ is the same formula as Dip-n-Go SLUDGE™, but without graphite, making it hold even stronger and a little harder to remove the bead. It is preferred by some borosilicate (hard glass) workers. Original SLUDGE PLUS™ and SUPER BLUE SLUDGE™ are the predecessors to the newer flame dryable Dip-n-Go mandrel releases. They are not easily flame dryable and are still available for those that do not want to switch to the newer Dip-n-Go mandrel releases. Here are some techniques and hints to obtain optimal performance.

If left unused too long all SLUDGE™ products will separate and will need to be remixed. If it does not reconstitute after shaking, stir it, then shake it again. Repeat as necessary. The consistency can be changed by adding water or by leaving the lid off to evaporate away water. SLUDGE™ products do not get old even if they become completely dry. Water will reconstitute it.

To coat the mandrel evenly we recommend the following procedure: Hold the end of the mandrel loosely between your finger and thumb. Quickly dip the mandrel into the release and then quickly pull it out. Holding the mandrel this way insures that it will go straight in and straight out and make a round coating. If the mandrel is withdrawn at an angle, the coating may have a ridge down its length. The action of dipping the mandrel quickly causes the release to coat thicker. To coat the mandrel even thicker, quickly and continuously dip the mandrel in and out several times. The more you repeat a fast dip, the thicker the coating. This is better than dipping, drying and then dipping again. Dipping the mandrel slowly applies a thinner coat. A mandrel with a very thin coating is hard to remove from the bead if it is bent. Optionally, you can turn the mandrel around and gently tap the end opposite the dipped end on the table surface. This gives the coating a very smooth surface. Turn the mandrel back around and vertically place it in a holder to dry. A container filled with sand works well. After coating the mandrel let it air dry or if it is Dip-n-Go SLUDGE™ or Dip-n-Go Blue SLUDGE™ it can be dried at the very back part of a neutral flame or within a very strong reduction flame. When dipping a large mandrel such as an Emiko Mandrel™ or a Thimble Mandrel the tip of the mandrel will form a peak. The peak is easiest removed by letting it air dry and scraping it to remove the unwanted area.

After the mandrel is either air dried or flame dried, heat the mandrel until red hot for one full second in the area where the bead will be. The magic about SLUDGE™ is that it holds beads when they are hot and releases them when they are cool. This will happens best if the area of the mandrel release holding the bead has been heated until red hot before glass was applied to it. If a bead is ever difficult to remove form the mandrel, you most likely did not get the coating hot enough or you chipped the mandrel release and the glass stuck directly to the steel mandrel. When heated properly, the coating will lose its strength permanently after cooling, but remain strong before cooling. For this reason, apply glass to the mandrel while the coating is still very hot. It need not be red hot, but almost. If the bead ever spins off while you are making it, you probably did get the mandrel red hot, but then let it get too cool before applying glass to it. Once glass is on the mandrel, proper beadmaking techniques will assure that the glass will hold enough heat to keep the coating hot. If bubbles appear in the glass near the mandrel release, the mandrel release was probably not dried thoroughly. Mandrel release that gives way to the sides of the bead is caused by excessive and unnecessary heating.

Hints: Once the mandrels have become dry enough to handle, you can quickly and thoroughly dry them by placing them on top of a hot annealer.

If you are making a very long bead, perhaps two or three inches long, you may find it difficult to keep the entire bead properly hot. Typically, what happens is that while you are heating one end of the bead in the flame the other end is getting too cool. Of course the mandrel release is also getting too cool. Besides the bead possibly breaking from uneven heat stress, you might find that the mandrel release has also cooled so much and that it may give way while you are still working. To remedy this problem, only heat the mandrel release to red hot where it will be in the central part of the long bead. Near the bead holes where the mandrel release never became red hot, the mandrel release will be strong while hot and stay strong even if it gets too cool. This procedure will make the bead only slightly harder to remove from the mandrel, but will insure success.

Arrow Springs

Reduction Glass

Reduction glass reacts to a reduction flame setting producing a raku like effect, often with metallic overtones. Reduction glass is usually in the form of rod, frit (granulated) or powder. Glasses that are formulated and sold as a reducing glass will have a different and desirable look after they have been reduced. Their look before being reduced may still be desirable. Some glasses not sold as a reducing glass may also reduce, but usually with undesirable results. Reducing is achieved in the flame and is accomplished by subjecting the glass, while molten, to a reduction flame atmosphere.

To use, make the entire glass item in a neutral flame from the reduction glass, or, as is more common, apply the reduction glass to the surface of a compatible glass base. When using frit or powder, the use of a marvering pad, frit tray or frit trough is very helpful. Completely melt the glass and bring it to its final shape.

One method of reducing the glass is to simply cut back on the amount oxygen or increase the amount of the fuel gas while working the glass in the flame. Experiment with different ratios to find the best flame setting for you and your burner. This first method is less intimating and tends to yield a darker and less metallic look then the second method.

The second method is done by completely turning off the oxygen flow and increasing the fuel gas until it actually pushes off the face of the burner by as much as several inches. This flame setting is popularly known as dragon’s breath. This makes a clean flame and will prevent soot from accumulating on the glass. Place the molten glass fully within the base of the flame. This large flame setting may seem hot to you, but in fact is not hot enough to keep the glass molten. The reduction process begins within a couple of seconds and is finished when the glass is no longer molten, usually ten seconds or less, dependent upon how hot the glass started out. Also experiment in different areas of the dragon’s breath flame to obtain different reduction colors. Because this flame setting is so cool, it may also take care of the flame annealing.

Practice this kind of flame setting before using it on your glass. Adjust the burner to this kind of flame setting with the glass not in the flame to prevent the glass from becoming dark as it tends to in the first method described above. If the fuel gas is increased too much the flame will blow out. Turn off the gas before relighting. Also, reduce the flame until it comes back in contact with the face of the burner before turning on the oxygen or it too will blow out the flame.

Any reduced glass put back into a neutral or oxidation flame will become unreduced and the process will need to be repeated to get it back. Darkness produced from the first method described is usually permanent.

What is a Neutral, Oxidation and Reduction flame?
A neutral flame has a perfect balance of fuel gas and oxygen as supplied through the burner. An oxidation flame has more oxygen supplied to it than the fuel can consume. A reduction flame does not have enough oxygen supplied to it through the torch and must get the balance from the atmosphere. The chemistry of a reduction flame can have dramatic effects on molten glass.

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Pixie Dust

Use Pixie Dust to create a sparkle or pearl luster color inside glass or on its surface.

To use, form glass to its final shape. Allow the glass to harden but, still remain hot. Quickly heat the surface of the glass until molten. Avoid allowing the inside of the glass to become molten or it will probably loose its shape during some of the following application methods. Any of the following methods can be used to apply Pixie Dust powder. Pile Pixie Dust onto a metal or graphite work surface. Dip the glass into the powder and rotate it around until the glass is covered. The powder will only permanently adhere to molten glass. If you find that the powder did not adhere to the glass, it was not hot enough. The glass will coat with a thick layer of powder, but only the layer of powder that is in direct contact with the molten glass will adhere. The rest will be loose. Put the glass back into the flame to flame anneal it. Only use the cool end of the flame or the powder will burn onto the surface of the glass and the item will probably be ruined. Another application method is to place the powder into a shallow metal tray or Frit and Powder Trough. Apply the powder by inserting the glass in and rotate. Because Pixie Dust is made of mica, it is an excellent insulator. If the glass is completely engulfed in the powder, it performs a pseudo kind of flame annealing. You can also apply the powder by sprinkling or sifting it onto the glass. An enamel sifter works well. Sprinkling or sifting is the best method when you only have a small amount of powder to work with.

To encase glass that has just been coated, wipe off excess layers of powder first. Use a dry cotton cloth and wipe with a quick motion. Be careful with how you handle the cloth and where you put it, because it will get very hot and may catch fire. If you attempt to apply glass on top of the powder without wiping off the excess layers, the glass will just fall off, because it will only have stuck to the loose outside layer. Pixie Dust that is encased is protected from the flame and will not burn. The color of the glass that the Pixie Dust is applied to affects the final look. You can do a quick color test by simply coating the end of a glass rod. Even if you do not encase the glass after coating it, you can wipe off the excessive layers of powder to see if the application was successful.

You can also make a glass rod with Pixie Dust dispersed throughout it. Heat up a quantity of glass until molten. Mash it flat. In the center of the flattened glass, place a small amount of Pixie Dust. Without spilling the Pixie Dust, heat the opposite side of the glass in the flame until it becomes soft and pliable. Carefully fold the glass, trapping the Pixie Dust and sealing it in and away from possible direct contact with the flame. Do this while forcing out as much air as possible. Using the glass rod that the original flattened glass came from, as a punty, and another glass rod, mix the glass in the flame until well blended. Pull out into a rod.

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Making Glass Core Vessels

Glass core vessels were one of the first glass items ever made, perhaps preceded only by glass beads, small glass sculpture and imitation stones. Originally, glass core vessels were formed over a mixture of sand and clay that was sometimes supported by a metal mandrel. Today the process is similar, except with today's modern materials available to us we can modernize the technique while still keeping the integrity of the process developed thousands of years ago by glass pioneers. This method can be used to not only make vessels, but also large hollow beads.

Take 00 or 000 steel wool and pull it apart to make thin, narrow, long layers. Wrap it around a stainless steel mandrel. An 1/8" or larger mandrel is better than the smaller sizes, because the larger size mandrel holds the steel wool better and helps prevent it from spinning loose while working the hot glass. Wrap the steel wool tightly at first, so it won't slip, and then a little looser so as to be able to make the wrapping go into the shape you want. The steel wool wrap can be placed near the end of the mandrel to make an item with a hole at each end like a bead, or at the very tip and even past the tip to make a vessel.

When you are satisfied with the shape, use a small brush to cover it with Dip-n-Go SLUDGE™ mandrel release. Apply several coats, if necessary, allowing them to naturally dry between applications. The final thickness of the coating should be at least 1/16". Make sure that the mandrel release covers all of the steel wool, not just where the glass will be applied. A full coverage coating adds a lot of strength to the steel wool and helps in keeping the mandrel from spinning free. It also insulates the steel wool from direct contact with the flame which would otherwise easily burn up. You can smooth out the surface with your finger before the mandrel release dries or you can wait until it dries, wet your finger and smooth the surface. The second method gives you more control, because it only affects the surface leaving the under coat to hold the shape.

Once the mandrel release has fully air dried, introduce it to the flame to heat it up similar to when making a regular wound bead, but don't let it get too hot or the extra thick coating of mandrel release may crack and the steel wool will burn up. If a little cracking happens or if a little steel wool burns you should have no problem, but the core will be a little more delicate.

Finally, apply the glass where you want it. Work it as you would if making a regular wound bead or sculptured glass. Be very careful to not pull or push too hard or the core will slip from the mandrel. If you use an opaque glass to cover the mandrel release, any of the coating's surface imperfections will not show from the outside of the glass. You will not have to be so fastidious about cleaning out the inside.

After annealing, remove the steel wool by picking it out. The mandrel release is harder to remove. It can be removed by scraping or you can use a moto tool with a diamond burr.

Arrow Springs

Making Glass Frit

You can make frit several different ways. In all cases, be sure to wear proper protective eye wear and take all necessary precautions such as using a dust mask and gloves.

1) Heat up glass in a torch or kiln and plunge it into water. The hotter the glass is, the smaller the frit size will be. You may need to gently crush it to separate the fractured glass.

2) Cut small pieces of glass and break them up in a hand held coffee grinder. Gently shake up and down. The longer you grind, the finer the frit. This ruins the coffee grinder for grinding coffee. Some coffee grinder lids are brittle and can shatter. Use caution.

3) Wrap the glass in cloth and crush it with a hammer.

4) Place the glass in a metal cylinder that has a bottom and crush it with a metal plunger that fits the cylinder tightly.

5) Run glass through an old garbage disposal that has been removed from the sink and secured to a stout table.

6) Use a ball mill. This is the most expensive tool and least easy to find, but it gives the finest grind - all the way down to a very fine powder if so desired.

7) Use a mortar and pestle. This tool is best used to make large frit into smaller frit.

Any time you break up glass, the surface of the tool that comes in contact with the glass can ablate and then be mixed in with the frit. A large magnet can remove most of the iron containing contaminants. You do not necessarily need to worry about the small amount of contaminants, as some applications with frit won't show them anyway.

Some of the described methods will produce a variety of frit sizes simultaneously while others tend to produce the same size frit. You can sift the finished frit through different size screens.

Once the coffee grinder or garbage disposal are used on glass they are worthless for their original design, but can last for many hours of frit making.

Using a Button and Knob Mold

The easier way is to first set the mold on the table with the profile you want to use facing up. Shim underneath the handle if the mold is not laying flat on the table. Then heat a symmetrical blob of glass on the end of a glass rod. Bring the glass blob over the mold profile, with the rod perpendicular to the table. Let the blob barley stretch away from the rod just enough to help the molten glass to become a little better shape. This stretch needs to be very little. If the glass is very hot and you stretch it too much, the glass will get away from you and you will need to remelt it back into shape. Now bring the molten glass blob to the bottom of the profile, as close to center as you can, and push the rod down. This drives the molten glass outward, towards the rim of the profile. If it is not filling the cavity equally in all areas, you can steer the advancing glass with the rod as it is being pushed down. The glass that you see in the mold is the back of the button or knob. It will look like a bagel surrounding the glass rod.

It will take you a few attempts to develop the intuition of how much glass to melt. The first time the molten glass is pressed into the mold it cools and sets its shape fairly quickly, almost always before you get the glass to flow to where you want it. This is not a big deal, because you also unlikely have melted an incorrect amount of glass and will need to remelt it again anyway. The next time you push the glass into the mold you will find that you have more working time, because the graphite is hotter. It doesn't cool the glass as fast. As the graphite gets hotter and hotter, the more working time you will have. You can, of course, preheat the graphite in the flame, but do so very carefully at a low heat. Graphite disintegrates at high heat. You will weaken it and lose detail.

When you are happy with the formed glass, pull it from the mold. The glass rod is now a punty. Decorate the face of the button or knob as desired either before or after the back of the button is completed. This depends on your style of working as well as how you want the back to be made. The rod can be melted or nipped away. You can insert a metal loop into the heated glass (attach punty to the front first), glue an aftermarket metal loop on after it cools, or make a glass loop using a tungsten rod and or Peters Tweezers.

When you heat the back, center of the button with a regular, neutral flame, you will find that often the edge of the button becomes soft and will distort before you are done working on the center area. This can be prevented by using an oxidation flame. Increasing the oxygen will do this, but reducing the fuel gas will also do it and make a smaller flame than increasing the oxygen. Do whichever gives you the size flame that works best for the situation. This oxidation flame pinpoints the heat at the tip of the flame and the excess oxygen keeps the glass area outside the point of flame contact from getting too hot.

The second method of using the mold is very similar. The difference being, as you are pressing the molten glass into the mold profile, you are also rotating the glass rod and pressing the glass down with a paddle as it rises above the edge of the mold. Like described above, the mold cools the glass, but now so does the paddle. Until they both get hot, working time is even shorter. This procedure is to make the back of the button flatter and have a crisper edge on the back. This method takes more practice to make the paddled area not look so choppy from paddle marks. It is all about holding the paddle parallel to the mold as you pat the glass, having the correct amount glass (the other method is more forgiving on having an exact amount of glass) and having enough heat in the glass and in the graphite to give you enough working time to get it done before the glass cools.

Yes, this all sounds like a lot to do and think all at one time. Just as it did to learn how to spin a mandrel without holding your breath, it really takes very little practice, especially for using the first method.

Arrow Springs

Stringer Test for Compatibility

Not everybody trusts this test but, if done accurately, can be a very reliable.

Take two glasses that you want to test for compatibility. If they are not the same diameter, make them so. If you use unequal amounts of glass, you will get a false reading. The glasses need to be of contrasting colors in order to be able to work with them properly and to read the results of the test.

Heat one end on both rods and then touch them together so that they align down their length. They should overlap about one inch. Now heat the joined area in the flame until they are completely fused together. It is very important that you do not twist. When the joined area of the glass is uniformly hot, pull it out into a stringer. Keep pulling the stringer, keeping it straight, until the glass hardens. Pull at least an 18” stringer. If you twist as you pull, you will cancel out any tell tale effects that would normally show up in non-compatible glasses. You can pull vertically to avoid the effects of gravity.

When the glass cools, cut it to 12" long from the center of the pull. If the stringer bends by itself, the two glasses are of a different COE (coefficient of expansion) and are not exactly compatible. When you heat glass, it expands. When it cools, it contracts. Glass with a high COE expands more when heated and then contracts more when cooled than glass with a lower COE. Since the two glasses were joined while molten, any differences in the amount of contraction as they cool and stiffen will reveal itself by bending the stringer. The glass that is on the concave side of the bend has the higher COE, because it contracted more. If the curve falls away from a straight line too much, it may not be compatible for your application. Glasses used for beadmaking can have more curve in it than glasses used for fusing, especially large fused pieces. Opinions for the amount of acceptable curve range from about ¼" to ¾" as measured by pressing the last ½” of the stringer against a straight edge and measuring the distance the other end of the stringer pulls away from the straight edge.

To make this test more significant, you should also do a test to determine how close to the same temperature the two glasses soften, even when the stringer test shows that the glasses are compatible. The glasses are not annealed under ideal conditions and different glasses may cool and stiffen differently in the open.

Make single color stringers from the colors to be tested. They must be identical in diameter and the same length. Place them next to each other, but not touching, in a kiln so that they are held at one end. They should be parallel to the floor and elevated from it. This is easiest to do by pinching them between two kiln bricks or shelf posts. Heat them up slowly and observe the temperature at which each bends. If you heat them too quickly, the results may be distorted. For instance, black glass absorbs heat faster than white glass. If you heat up black and white quickly, the black glass will melt first, even if their melting temperatures are identical. For best compatibility, the bending temperatures should be within 50º F of each other.

Arrow Springs

Connecting Multiple Tanks to a Torch Manifold System

With the following instructions and illustrations, you will be able to set up a single torch or a multiple torch manifold system, using two oxygen tanks and two propane tanks that will automatically switch to the second tank when the first tank is empty. Although this will give you twice as much oxygen and propane to work with, the big advantage of this setup is that when one tank becomes empty, the second tank automatically takes over without any interruption to the operation of the connected torches. While the second tank is continuously supplying the torches, the empty tank can be changed. Even with a lot of large torches running, there will not have to be a panicked hurry to change the empty tank, because you will have as much time to do so as the second tank will last. With the following procedure, all torches connected to a torch manifold can be operated indefinitely without interruption.

SETUP

The following diagrams show two tanks connected by a hose. Both tanks must be of the same gas. In other words, both oxygen or both propane. The diagrams show how only one of the gasses is setup. The other gas is setup identically, but independently from the other. The diagrams show that each tank has a pressure regulator connected. If operating more than six torches, especially large torches, you should use a larger pressure regulator than is industry standard for one or a few torches. A two stage pressure regulator is not necessary or even recommended. Connected to each pressure regulator is a flashback arrestor. The key part that makes this system work, as described above, is the check valve that each flashback arrestor has built within it. You can substitute with quick connects, which also have check valves built in, or with just check valves, but the flashback arrestors give the added safety benefit of stopping a flashback, should one ever occur. Connected to the flashback arrestor on the left tank of the first diagram is a T-Splitter. You can use a Y-Splitter instead. Connected to one of the two open ports of the splitter is a 3/8" diameter hose, appropriate for the gas being used. The other end of the hose is connected to the flashback arrestor on the other pressure regulator shown in the first diagram. A good length for this hose is 6'. Shorter restricts placement of the tanks. Longer is usually in the way. Connected to the one remaining open port of the splitter is a 3/8" diameter hose, appropriate for the gas being used, that leads to a connected manifold. This hose is typically 12½' in length. A 25' hose will allow the tanks to be placed further from the torches. The actual length of both hoses should be what best works with your situation. The torch manifold is usually placed centrally to the location of the connected torches. If the studio layout calls for two manifolds, simply add another T or Y-Splitter to the output side of the flashback arrestor on the tank on the right, as is shown in the second diagram, and connect as before. The second manifold will operate from the same gas source simultaneously. The diagrams show manifolds capable of connecting six torches each, but you can use a manifold with any number of connecting ports within practical limits. Be sure to apply all safety procedures when setting up this system as you would normally do for a single tank setup. For example, do not remove the cap to an oxygen tank before it is firmly secured in a safe location. Make sure regulators, hoses and all other components are properly connected and tightened. All manifold ports not being used are capped or have quick connects connected. Never allow oil or grease to come in contact with oxygen, which can cause an explosion. Check for leaks.

OPERATION

Follow normal procedures for opening tanks. Make sure that all connections are properly secured. Turn all torch valves off. Back off the pressure setting handle on each pressure regulator. Leaving the pressure set on a regulator when opening the tank's valve may cause damage to the regulator. Open both tank valves slowly for the first turn. Open oxygen tank valves fully and firmly. Check for leaks. Open propane tank valves two full turns. Check for leaks. Set the pressure on either one of the oxygen pressure regulators to 30 to 40 pounds. Do not set the pressure on the other oxygen pressure regulator yet. Set the pressure on either one of the propane pressure regulators to 15 to 20 pounds. Do not set the pressure on the other propane pressure regulator yet. Light at least one torch, using both gasses. Now go to the second pressure regulator of the oxygen. Turn the pressure setting handle slowly, just until you begin to hear the sound of gas going through it. Then back off the setting just enough to stop the sound and therefore the gas flow. The pressure set on this pressure regulator is now set slightly lower than on the other pressure regulator. Repeat this procedure on the second pressure regulator of the propane setup. You are now setup and ready to use all connected torches.

Using these higher pressure settings will buffer out pressure surges to each torch when one torch is turned on or off. Pressure regulators also perform better and have a longer life when they are set to higher pressures. Some propane pressure regulators have a red danger zone on the delivery pressure gauge. This only applies when the pressure regulator is used with acetylene. You can disregard it when using propane. Many torches give suggested pressure settings that are lower than what is stated here. These pressures are actually what the torch works best at, at a minimum. Supplying higher a pressure does not affect your ability to adjust the flame size nor does it increase gas consumption.

The way the system will now work is as follows: The tank with the pressure regulator that has the higher pressure setting will be consumed first. When this tank's pressure drops to what the other tank's pressure regulator is set to, the other tank will then come online and it will then be consumed. Without interrupting the operating torches, the first tank can be disconnected and a full one can then replace it. Do this by first backing off the pressure setting on the pressure regulator connected to the empty tank. Then turn off the empty tank's valve. Disconnect pressure regulator from empty tank and connect it to a full tank. The check valve in the flashback arrestor will not allow gas from the other tank to pass through and out the pressure regulator while it is disconnected. As before, open the tank valve slowly for the first turn, then fully and firmly for the oxygen tank or two full turns for the propane tank. Set the pressure regulator pressure, as described above, to just slightly below the other. If you set the pressure as described here, you will notice that after several tank changes, the pressure setting will be a little lower than when you first stared. This is because each time you change a tank, the new one is set to a lower pressure than the one running. Make adjustments as necessary.

A 20 pound propane tank (often referred to as a 5 gallon tank, but actually holds approximately 4½ gallons) will last about as long as 4½ K (240 cubic feet) or KH (282 cubic feet) size oxygen tanks. Because of this, and because if an emergency occurred where you would need to quickly turn off the propane tank(s), you might consider only turning on one of the propane tanks. Turn on the second one after you notice a change in the flame that indicates the propane is running low. The second tank is already setup. You will be able to quickly turn it on without any significant interruption.

Kits are available for each gas containing two larger pressure regulators, two flashback arrestors, one T-Splitter, one 6' hose, one 12½' hose. Substitutions on hose lengths can be made. Add to the kit the size torch manifold you will need to connect the number of torches you plan on using. If you are an instructor and travel a lot with this setup, consider using a combination flashback arrestor and quick connect at each pressure regulator and quick connects at the torch manifolds.