Tech Talk

The first in a three part installment, Henry Grimmet gives an insightful look at torch setup.

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Section 1.01

(a) Setting up Your Torch

Those that have visited Glass Alchemy, Ltd. or have attended a G.A.L. workshop know that the underlying assumption is that you are a professional lampworker making a living off the torch and that holds for this article. The hobbyist will also gain great insight from the information that follows.

There have been many articles and books written over the years about how to choose the right torch; this article is focused on how to set it up once it arrives in the studio or shop. The setup often turns out to be more influential on the final outcome of the piece than the original choice of torches and for this reason the lampworker must understand the fundamental factors involved.

Unless you are working on a Hothead™, there is a fuel and an air or oxygen supply. These gasses pass through orifices and valves in the regulators, then through supply lines to more valves at the torch and then through burner tubes (orifices) and hopefully burn in a smooth laminar flow. Laminar flow can best be visualized as a fast moving river where the layers of water flow without mixing or turbulence. Laminar flow provides even heat when looking at a cross section of a flame.

Torch designs vary considerably. There may be two fuel ports for each oxygen port or the design can be one to one. The fuel/oxidizer mixing may be internal, external or a combination of both. Less obvious, the port sizes can be very different between torches. The amount of fuel that flows at two pounds of pressure through one torch can be one hundred percent more than another model or brand. If the manufacturer designed the torch for high volume and low pressure then it is not desirable to use a small-bore supply line with a high-pressure setting.

The fuel gas is often propane (LP) or natural gas (CNG) but can be butane, mapp gas among others. For the purpose of this article the focus will be on propane (LP) gas. (See Propane Sidebar) References to oxygen also apply to the use of air. The use of the word gas, without denoting which, refers to both oxygen and propane.

Supply line architecture is of extreme importance for a proper setup. In an attempt to save money one may choose a smaller diameter hose/pipe thinking that "20 pounds of pressure is 20 pounds of pressure", not considering the pressure drops associated with the various diameters of supply lines, or the volumes that can actually be transported through these long tunnels. The symptoms of this problem vary. Often there is not enough oxygen to fully combust the propane and a reducing flame results. This type of flame can inject carbon into the glass and shift the refractive index such that the color is not bright, the carbon can reduce certain metals used as colorants (such as cobalt turning gray) and in extreme cases cause the colors to go "muddy". The common solution is to increase the pressure to increase the volume, which introduces many other problems but does not increase the volume. It is like putting your finger over the end of the water hose and opening the valve, the water squirts farther but there is not much more of it. Increased pressures are a primary cause of turbulent flow and often results in a cooler, reducing flame.

Another common decision is selecting the proper diameter but the wrong material and as a result suffering with torch performance issues due to the sidewalls of the hose/pipe sloughing off material that plugs the valves and burner tubes of the torch from the gas supply side. (See Rubber Hose sidebar)

Selection of the valves and regulators is also of great importance because they are the primary controls of the gas flow from the source to the torch. Should they be single or two-staged, low pressure or high pressure? When using a manifold for several torches where should the regulators go in the setup? (See Regulator's sidebar)

(b) Putting It All Together

First, if there are employees involved then there are many additional legal responsibilities. It is important to have documented training programs and written testing on how to properly use propane and propane tanks, how to handle oxygen tanks and regulators and how to inspect supply lines for wear and tear. Either the trainer has to be trained by

attending seminars or an outside consultant needs to be brought in to provide the training. Consider contacting your vendors and asking them if they have a program that will meet your needs.

If operating multiple torches "hard-lines" such as copper or stainless steel tubing should be plumbed in. Never use PVC, especially for the fuel gas. (Note that a poorly installed propane system may cause a potentially dangerous or life-threatening situation and all building codes should be followed. If you install the hard line system rather than using the services of a professional then be familiar with National Fuel Gas Code, ANSI Z 223.1and the National Fire Protection Association (NFPA) 58.) Some of the basics include: always use flare fittings, isolate copper tubing from contact with other metals (to prevent electrolytic corrosion), separate gas lines from electrical conduit by a minimum of four inches and consider additional shut off valves for the fuel gas, especially if the tank and regulator are outside.

When using flexible supply line such as welding hose or reinforced clear polyurethane tubing such as Tygothane® it is important to verify that the material can be used with propane under pressure. If the hose material is purchased from a hose supplier rather than a nationwide-wide discount store obtaining the brand name, "part-number" and specification sheet is generally very simple. Sometimes a call to the manufacturer is necessary to answer a very specific question. At GA we selected a ½ inch I.D. reinforced Teflon tubing with braided stainless steel cover for flexibility, heat and abrasion resistance and very high pressure ratings.

To achieve laminar flow at the torch the basic goals when setting up the torch are to know that enough volume of gas is being delivered and to be able to stabilize the flow. By utilizing a regulator or flow-valve at the tank and an in-line regulator mounted at the bench you can ensure adequate volume and control. From the first stage to the second choose a supply line bore based on the number of torches, for example ¼ inch would support one larger torch or two smaller torches while F inch might support three larger torches. From the in-line regulator to the torch use a bore size that will slip onto the fitting supplied with the torch keeping the length to a maximum of about four feet. If only the first stage regulator is being used and the desire is to improve color results use the shortest supply line lengths possible. In the case of a propane tank that is stored outside consider using a larger bore size and a protective shelter to minimize temperature fluctuations.

To summarize, it is important to know the demand of the torch for gas and air in an all-out situation. The regulators need to be capable of supplying this demand. Due to pressure drop issues supply lines should be short and of significant enough bore to deliver the demand volumes. Simply increasing the pressure to get more juice is very similar to over pumping the beer keg... foam. The same thing happens in the torch, the laminar flow becomes turbulent and the flame consists of hot and cold spots. It takes longer to pull points, build sculpture and the colors become dull.

When the torch is set up properly and the correct propane and oxygen settings are chosen the colors are no longer dull, rather they remain bright.

G.A.L. says Safety First.

Insight

Propane

Propane is a liquefied petroleum gas and aromatic hydrocarbon that is heavier than air. Unlike liquid butane that will not vaporize at temperatures less than 32 degrees Fahrenheit, liquid propane will vaporize at any temperature above -44 degrees Fahrenheit. A gallon of liquid propane weighs 4.24 pounds and contains 91,650 BTU's. Propane, and all other hydrocarbon based fuels, must be kept away from open flame(s) and ignition sources. Propane must also be handled with care, transported properly, and stored safely. Liquefied petroleum gas acts a solvent on all petroleum products; for that reason use special pipe dope containing no mineral oils or rubber.

Any propane system may develop faults that will allow propane vapor to escape. Propane vapor most often evidences itself via its distinctive unpleasant odor. The presence of propane's distinctive odor indicates that propane vapor is likely to be present and a potentially dangerous situation may exist. Should this situation ever present itself, extinguish all open flames and immediately leave the area where the odor is present. Do not touch any electrical switches or appliances. Go directly to your propane system's storage vessel and close the vapor service valve. Depending on your set-up and level of experience either call

[Propane continued]

someone in to test for leaks or test for leaks yourself.

In rare instances, certain individuals may be unable to detect propane's odor. In these situations, an electronic leak detector should be utilized.

Safety Reminders

1. Propane vapor is heavier than air. As such, in the event of an unintended release of propane vapor, the vapor will migrate to the lowest point. In example, your basement or crawl space.
2. Do not tamper with your system's supply lines or appliances
3. Do not tamper with any safety devices, regulators or storage tank fittings.
4. Familiarize yourself and others with the location of your storage tank's vapor service shutoff valve.
5. Never test for a propane leak using an open flame. Only suitable leak detection solutions may be used.
6. Propane must be handled with caution. In the unlikely event that a propane leak should occur, take the following steps:
   a. immediately shut off the storage tank's service valve.
   b. Eliminate all possible outside sources of ignition.
   c. Do not turn on any light switches

Other Notes of Interest

The odor, ethyl-mercaptan, is present in the parts per million but accumulates in the bottom of the tank along with moisture and other petroleum fragments. Sometimes when working clear glass it will start showing a gray film like material. This film may indicate it is time to take the tank to the vendor and have it drained. Do not attempt this yourself, as the valve will distort if removed with the wrong tool.

The new OPD valves required on tanks from four to fourty pounds (one-ten gallons) have a restricted flow and do not deliver the same volumes as the old tank valves. If there are several torches on the system it may be necessary to use a larger tank that is exempt from the OPD valves.

Rubber hoses

In recent years, there have been developed or adopted a number of fuel gases based on specific hydrocarbons or mixtures of hydrocarbons. It is known that these special fuel gases have a different effect on rubber compounds than does acetylene. The precise effect on all the many and varying hose compounds and constructions of the many manufacturers have not been determined for all the known special fuel gases.

A characteristic of rubber hose that is significant in its use as welding hose is a phenomenon known as permeation. Any gas confined in the bore of a hose exhibits a tendency to pass through the tube wall and subsequently through the reinforcement and cover to the environment. Each gas has its own specific characteristic tendency to permeate. Each rubber compound exhibits specific resistance to permeation. The rate of permeation increases with higher temperature. To minimize the permeation of fuel gas through the hose wall it is logical to design the tube compound for the lowest possible permeation rate. The problem in the case of welding hose results from the variety of gases now encountered, the varying pressures used in service, and the varying temperatures to be found in the work place. The need to ventilate the work place is evident, both for maintaining the lowest practical temperature and to dissipate the permeating gas, however slight, to prevent buildup to concentrations that are either explosive or dangerous for breathing by lampworkers.

Some rubber compounds are known to have low permeation rates with several fuel gases but no specific rule can be laid down to predict overall performance. Thus, it becomes advisable to check the characteristic of each hose construction with each gas under actual or simulated service conditions to qualify it for use.

CAUTION:

Users of welding hose are urged to communicate their service conditions to the hose manufacturer and obtain the best recommendation of the manufacturer for a hose suitable for those conditions. Typically a flexible rubber hose should meet RMA/CGA IP-1-90 standards. Grade T (not Grade R) welding hose can be used. (RMA = Rubber Manufactures Association, CGA = Compressed Gas Association, both on the WWW.)

LP-Gas Regulators

The regulator truly is the heart of an LP-Gas installation. It must compensate for variations in tank pressure from as low as 8 psig to 220 psig – and still deliver a steady flow of LP-Gas at 11" w.c. (water column) to consuming appliances.

Though a single stage system may perform adequately in many installations, the use of a two-stage system offers the ultimate in pin-point regulation.

Two Stage Regulation

Two Stage Regulation has these advantages:

Uniform Torch Pressures - The installation of a two-stage system – one high pressure regulator at the container to compensate for varied inlet pressures, and one low pressure regulator at the torch to supply a constant delivery pressure to the appliance – helps ensure maximum efficiency and trouble free operation year round. It is important to note that while pressure at the torch can vary up to 4 inches w.c. using single stage systems, two stage systems keep pressure variations within 1 inch w.c...

Reduced Freeze-ups - Regulator freeze-up occurs when moisture in the gas condenses and freezes on cold surfaces of the regulator nozzle. The nozzle becomes chilled when high pressure gas expands across it into the regulator body. This chilling action is more severe in single stage systems as gas expands from tank pressure to 11" w.c. through a single regulator nozzle.

Two-stage systems can greatly reduce the possibility of freeze-ups as the expansion of gas from tank pressure to 11" w.c. is divided into two steps, with less chilling effect at each regulator. In addition, after the gas exits the first stage regulator and enters the first-stage transmission line, it picks up heat from the line, further reducing the possibility of second stage freeze-up.

Economy of Installation - In a single-stage system supply line piping between the container and the appliances must be large enough to accommodate the required volume of gas at 11" w.c. In contrast, the line between the first and second-stage regulators in two-stage systems can be much smaller as it delivers gas at 10 psig to the second stage regulator. Often the savings in piping cost will pay for the second regulator.

Allowance for Future Torches- A high degree of flexibility is offered in new installations of two-stage systems. Torches can be added later to the present load – provided the high pressure regulator can handle the increase – by the addition of a second low pressure regulator. Since appliances can be regulated independently, demands from other parts of the installation will not affect their individual performances.

Call the Torch Manufacture

Refer to the manufacturer's capacity chart for the size and type regulator which fits the demand for the torch. Check the performance of this regulator with your actual load at the inlet pressure corresponding to your lowest winter temperatures.