Brazing Best Practices: 12 Tips for HVAC Technicians

A prominent HVAC technician training school offers its guidelines for brazing quality high-pressure joints

By Chris Cordia and Greg Mitchell

While a sound understanding of soldering and brazing theory is important for HVAC (heating, ventilation, and air conditioning) technicians, it is their hands-on skills that define their ability to do the work properly. This article presents the 12 hands-on tips learned from experience and taught in classes presented at American Trade School, St. Louis, Mo. By following these tips, you can help ensure your brazed joints will withstand high-side operating pressures up to 500 lb/in.² and last the life of the compressor or evaporator.

**Tip 1: Deburr and clear the tubing.**
Burrs that remain on the outside edge of the cut can prevent tubing from fitting into the full depth of the cup, and burrs on the inside will cause turbulence in the refrigerant. Any copper shavings left inside the tubing can cause even more damage, as they can clog the liquid line filter and metering device orifice. After reaming (Fig. 1), turn the tube upside down, then knock out all the loose shavings. Be sure to inspect the inside of the tube before making the final dry fit.

**Tip 2: Clean the tube, coupling, and filler rod.** The parts should be cleaned with a 3M Scotch-Brite™ pad (Fig. 2) or a tool intended for that purpose. Technically, a copper-to-copper connection does not require cleaning because the phosphorus in the filler rod will act as a flux. In practice, it is recommended to remove the surface copper oxides before brazing. Note: Sandpaper should not be used for this purpose since the silica particles can come loose and cause problems similar to those caused by copper burrs.

**Tip 3: Ensure a tight fitup to promote good capillary action.**
Tight fitup to promote good capillary action, which is the movement of a liquid along the surface of a solid caused by the attraction of the molecules of the liquid to the molecules of the solid. A joint that lasts 30 years has filler material throughout the depth of the cup (the overlapping portions of the tubing, which will absorb the filler metal through capillary action and create the finished, brazed joint). A loose joint (Fig. 3) won’t provide the necessary capillary action, and “painting” or “pasting” filler metal on top of the joint just won’t provide the required strength. In fact, such a joint will likely crack from vibration.
Tip 4: Purge the tube with nitrogen. Copper oxidizes when exposed to room air at brazing temperatures. The same black-gray metallic flakes seen on the outside of a joint brazed in air will also be present on the inside of the tubing. These flakes can clog the liquid line filter and metering device. Purging the joint with nitrogen during brazing prevents oxidization from taking place. Figure 4 clearly shows the difference between a tube brazed without nitrogen purge (at left) and with nitrogen (at right). See Tip 12 on how to use a nitrogen purge kit.

Tip 5: Learn to use a variety of filler materials. Brazing filler rods are available with 15, 6, or 0% silver, with the balance copper and about 5% phosphorus. A high silver content provides a greater “pasty range” or degree of workable room before the metal turns liquidous at about 1450°F — Fig. 5. While a 15% silver rod is user friendly, it may cost 15 times more than a rod with 0% silver. Since you will be required to work with the filler rod provided by the contractor, it is important to be skilled in the use of all types.

Tip 6: Which torch is better — Air-swirl or oxyacetylene? The facts are oxyacetylene (4700°F) produces a flame nearly twice as hot as an air-swirl flame (2700°F). But among HVAC technicians, which torch to use is just a matter of personal preference. One of the authors prefers an air-swirl (air-acetylene) torch because the wrap-around effect of the flame makes it easier to evenly heat all sides of the joint. Air-swirl torches also automatically meter gas flow, so there’s no need to adjust pressure at the regulator, and of course, there’s no oxygen regulator at all. The other author grew up using oxyacetylene and prefers to use it, especially for larger-diameter pipe or when working outside on a cold, windy day. As an interesting side note, some technicians carry an adapter that lets them attach an air-swirl tip to an acetylene torch handle — Fig. 6. This provides the flexibility to use air-swirl for soldering, as an oxyacetylene flame is too hot for that process.

Tip 7: Carry several tip sizes. To adjust heat delivery for the application at hand, it’s necessary to use the correct tip size for the job — Fig. 7. Oxyacetylene users can throttle gas flow to some degree to control temperature, but it’s better to change tip sizes to control the temperature. In practice, most technicians carry sizes #0, #2, and a small multiflame tip.

Air-swirl torch users must change tip sizes to control heat delivery, as the gas orifice automatically meters a precise flow rate. Most technicians carry several tips for brazing, including an A-3 for tubing up to ½ in. in diameter, an A-8 for ¾- to 1-in.-diameter tubing, and an A-11 for ½- to 1¾-in.-diameter tubing.

Tip 8: For oxyacetylene, use a slightly carburizing flame. Unlike welding, which requires a neutral flame, HVAC technicians prefer a slightly carburizing (or reducing) flame. The small reduction in oxygen reduces the flame temperature, which provides a touch more control when brazing. Figure 8 shows a slightly carburizing flame, which is about ¾ to 1 in. long using a #2 tip.

Tip 9: Heat the tube, not the filler metal. Unlike gas welding, where the flame directly melts the filler rod, brazing uses the heat of the tube to melt the filler metal. Start by heating Fig. 4 — The interiors of joints brazed in air (left) vs. nitrogen purged.

Fig. 5 — Filler metal is applied to the hot tubing surface.

Fig. 6 — Brazing torch shown with an air-swirl tip.

Fig. 7 — Tradesmen typically carry an assortment of brazing tips.

Fig. 8 — A slightly carburizing (reducing) flame is more desirable for brazing.

Fig. 9 — The filler rod should follow the torch around the tubing.

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the male portion of the joint first, as it will automatically begin to transfer heat to the female (or coupling) portion of the joint. Next, evenly heat all sides of the female portion of the tube. As the tubing reaches brazing temperature, its color starts to change. At this point, touch the end of the filler rod to the joint. The heat of the tubing will melt the filler metal and capillary action will draw it into the cup. Be sure to direct the flame ahead of the filler rod; basically, the filler rod should chase the torch around the tubing — Fig. 9.

**Tip 10: Flame distance.** Whether using an air-swirl or an oxyacetylene torch, keep the bluest part of the flame just off the tube as you bring it to temperature — Fig. 10. Normal distances are about ½ in. for air-swirl and 1 in. for oxyacetylene. Note that oxyacetylene torch users might need to move the torch farther away to reduce heat input after the tube comes up to temperature or risk burning a hole through the tube.

**Tip 12: How to use a nitrogen purge kit properly.** First, connect a nitrogen regulator to a nitrogen cylinder. Set the low-side pressure to about 40 lb/in.². Next, connect a hose between the regulator and a blow gun or inflatable purge tip and send a blast of nitrogen through the line set to remove oxygen and contaminants. Remove the hose and connect a flow meter to the regulating device, through the metering device, through the evaporator and into the suction line, where nitrogen can escape so as not to pressurize the system while brazing. The brazing order is the same: liquid line going out of the condenser, liquid line entering the evaporator, suction line exiting the evaporator, and suction line entering the condenser.

![Fig. 10 — Keep the bluest part of the flame just off the tube during heating.](image1)

![Fig. 11 — Heating briefly after removing the rod ensures complete capillary action.](image2)

![Fig. 12 — An HVAC technician sets up the nitrogen purge kit prior to brazing.](image3)

**About American Trade School.** The school, www.americantradeschool.edu, offers a 60-week HVAC diploma program and a 90-week associate’s degree program. In these courses, students train about 60% of their time in the lab applying their classroom lessons, and within the first week are introduced to the fundamentals of brazing copper tubing in diameters from 5/16 in. to 1 1/4 in. Both programs are recognized by the Air Conditioning Contractors of America (St. Louis Chapter) and the U.S. Department of Labor, Office of Apprenticeship.