Q: We are a manufacturer of air-conditioning and heating products. We have several issues with our brazing. The biggest and most obvious problem we seem to have is using too much braze alloy. You can see this in the enclosed photos of some of our joints.

At this time, we’re not sure if it is due to the design of our joints, the skill of our brazors, or both. Perhaps it is something else we are not considering. Using the wrong braze alloy, perhaps? In our internal discussions we have a lot of opinions, and the consensus is that it is several things. Most of our joints are copper-to-copper tube assemblies, but there are some where we join copper to steel. We don’t have an out-of-control leak problem in the field, but we feel that achieving a sealed system comes at the cost of using far too much braze material and rework. Hand in hand with using too much alloy is the fact the joint aesthetics are poor. Our customers are not thrilled with the appearance of our joints. While the product doesn’t leak, a lot of times it sure looks like it will.

We use a 2% silver braze rod. The heating is manual torch brazing using oxy-acetylene. On some joints, we use single tip torches, and on others, we use double tip. It depends on the size and accessibility of the joint. Operator preference is also a factor. We have an internal training program that is hard to implement because we have a lot of turnover in our operators. We’re constantly faced with the issue of bringing new people up to speed. An additional challenge is out on the shop floor. After our operators have been trained, they develop bad habits and we don’t have a lot of resources to give them oversight and remedial training.

What steps can we take to reduce the excessive use of braze alloy and improve the appearance of our joints? I need a place to start.

A: Review the fundamentals when looking at your designs. You need good fit and proper clearance. What does this mean? Most braze joints can be made with a depth of 5 mm (0.200 in.). One habit designers tend to have is to make the joints too deep, and then management says you must fill up the entire joint volume. Figure 1 is a good example of a joint that is too deep. In looking at this joint, a couple of things come to mind. Being so deep, it is more difficult to heat. You must bring the entire joint up to braze temperature and then focus the heat such that the alloy is drawn into the joint.

Being copper, the heat wants to be drawn away from the joint. Heating it so the alloy is drawn into the joint may make it colder at the point you add the alloy. The way to overcome this is to keep adding braze filler metal.

Proper Joint Sizing

This joint also appears to be quite a tight fit, further adding to the difficulty of getting braze filler metal to flow into the joint.

The alignment seems to be poor also. It makes one side of the joint wider than the other. Braze filler metal has trouble penetrating and the operator keeps adding alloy. We recommend a fit no greater than 0.10 mm (0.004 in.), so even in a well-designed joint, there will be limited room in the joint to fill. Adding a bit of a flare cupping to the end of the female tube will help direct braze filler metal into the joint.

A benefit to making the joint easier to heat, i.e., tighter fit with smaller overlap, is the heating time will decrease. An associated plus is there will be fuel gas and oxygen savings.

Temperature and Torch Tip

There are a few things to keep in mind, however, when the subject is proper heating. Torch tip selection is important. Some joints need a broad flame and some are more targeted. Also, using a double tip may make the heating more uniform and faster. There are a wide variety of tips on the market to select from.

Additionally, you want to make sure your operators are using a reducing flame. The tendency of most operators, especially new ones, is to crank up the oxygen. The thinking is the hotter the better so they can get the joint done faster. This increases the oxidation on the assembly, so when you add the braze filler metal, it acts to inhibit flow. Again, most operators try to overcome this with adding more rod — Fig. 2.

The problem changes when you have dissimilar metals. In Figure 2, the joint was not brought up to proper brazing temperature. It is referred to as a cold joint. The steel wants to retain heat and the copper wants to draw it away from the joint. In this case, when the braze filler metal was added, the point where the rod was touched was underheated. Touching it with the braze rod cools it further, as the heat in the base metal is used to melt the rod. Adding more filler metal makes matters worse.

Figure 3 shows what can happen when joint accessibility is an issue. The close proximity of the tubes to each other makes them difficult to heat. It also makes it hard to add the filler metal. If not heated properly and
ten results in what you observe in the photo.

Training and brazer oversight are important things to implement and emphasize. There are excellent options available in industry to help you design and implement a training program. This is a must-do under any condition. You mentioned that you are using a 2% silver braze filler metal. This is for the copper-to-copper joints. You do not mention what you use for the dissimilar metal joints. The 2% is one of the most common choices for these types of joints, so I would not think a change in filler metal would help. I have a few ideas, though, that may.

**Filler Metal Considerations**

There are wire feeders on the market that allow you to control the amount of filler metal dispensed into a joint. Most are automated, but there are manual

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**Fig. 3 — Braze joints in close proximity showing braze overflow.**

designed such that the alloy can easily penetrate the joint, operators end up adding additional filler metal, just to be sure it does not leak.

**Part Size and Mass**

Brazing parts of dissimilar size and mass can cause issues as well — Fig. 4. Although the fittings being brazed are not large in Fig. 4, they do represent a different mass to heat than the thin-walled tube. If heat is not properly applied to the fitting, it will be difficult to get braze filler metal to seal the joint. Adding more filler metal to try to achieve good joint integrity too oft-
ones. They dispense a fixed amount of filler metal to each joint. It takes the decision-making on the amount of filler metal to use out of the brazer’s control. They use wire rather than rod, which gives a slight cost savings.

You do not mention the diameter of the braze rod you are using. The larger the diameter of braze rod, the more heat it takes to melt it and therefore get it into the joint. The extra amount of braze filler metal also sets you up to use too much as it is difficult to control a large amount of molten metal when you are trying to get it into a tight joint. We worked with a manufacturer to convert from a 2.4-mm (0.093-in.) diameter rod to a 1.6-mm (0.062-in.) diameter rod. It experienced a 30% drop in braze filler metal usage. Heating times were also reduced.

An additional thing to try is using flat cross-section braze rods rather than round rods. Some operators find it is easier to hit a spot on a tubular braze joint with a flat rod rather than with a round rod. This is particularly true on smaller joints. These flat rods are readily available.

In almost every case, by taking steps to reduce filler metal usage, you should enjoy additional benefits like reductions in energy costs, less rework, increased productivity, and better aesthetics. It is a good place to focus improvement efforts.

This column is written sequentially by TIM P. HIRTHE, ALEXANDER E. SHAPIRO, and DAN KAY. Hirthe and Shapiro are members of and Kay is an advisor to the C3 Committee on Brazing and Soldering. All three have contributed to the 5th edition of AWS Brazing Handbook.

Hirthe (timhirthe@aol.com) currently serves as a BSME vice chair and owns his own consulting business.

Shapiro (ashapiro@titanium-brazing.com) is brazing products manager at Titanium Brazing, Inc., Columbus, Ohio.

Kay (Dan@kaybrazing.com), with 40 years of experience in the industry, operates his own brazing training and consulting business.

Readers are requested to post their questions for use in this column on the Brazing Forum section of the BSME website brazingandsoldering.com.