BY TIM P. HIRTHE

Q: We are manufacturing refrigeration lines consisting of a variety of copper tubing joints. The joints are primarily copper to copper but we do have some brass valves and steel connections. We employ dozens of hand brazers over several shifts and have a tremendous variation in quality. We are using oxyacetylene torches. It seems that everyone makes the joints their own way. One of the most aggravating issues is that we have a great deal of braze alloy teardrops and spatter. I am sure we are using more braze alloy than is necessary. I have included a photo for your reference — Fig. 1. My preference is to find some other method of making these joints. We are continually told that we need to improve our training but it seems to me to be a training nightmare. There must be equipment we can use to minimize our brazer variation. What can we do to take the manual aspects out of the operation to try to get some consistency?

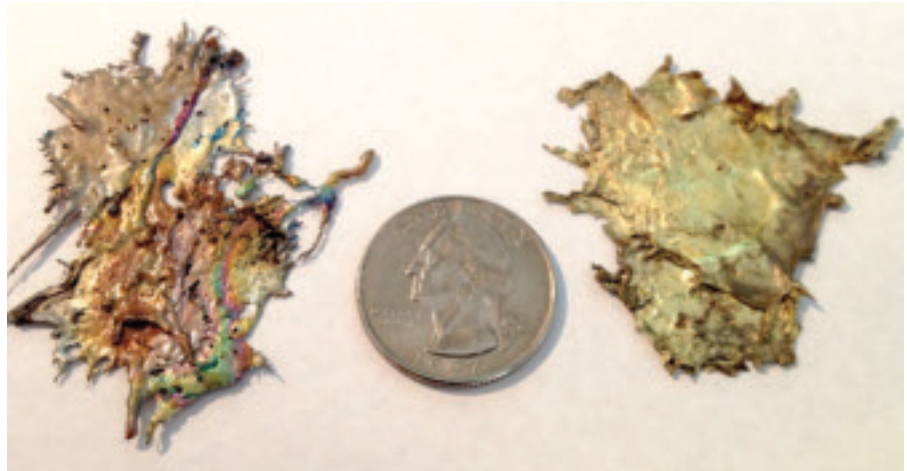

Fig. 1 — Examples of braze alloy drippings.

A: In my experience, manual torch brazing is the most difficult brazing process to get under control. Generally, the process and resultant quality are in the hands of the operator. It has a tremendous number of variables associated with it but the individual brazer level of training, their dexterity, and willingness to listen are probably the most important.

As you mention, the first reaction is to institute more training. Companies are hesitant because they assume it will take a great deal of time and when the operators get back on the shop floor they will revert to their bad habits anyway. That then requires lots of management intervention to keep things on track. Everyone is trying to eliminate headaches, and I'm sure the continuation of manual torch brazing seems to be a prescription for a long, extended headache. You are asking about the alternative, which is to take the brazer out of the decision-making process. That requires standardizing the process and, perhaps, adding equipment.

Your photo appears to show something more like drippings than spatter. I realize you want to find a magic bullet in the way of equipment that will eliminate the "brazer problem," and, while there are some things you can do in that regard, don't abandon the idea of improving training. The photo would seem to indicate a basic misunderstanding of the brazing process. There are a few simple things you can do to make improvements. The key word is simple. If you try to overdo it with training, the brazers may become overloaded with information and tune out.

The drippings in the photo are actually teardrops that fell off instead of solidifying on the parts. I have seen this before. It typically comes from the brazer applying the heat to the braze filler metal rather than the metals being joined. Either that or the brazers just blasted away at it and kept adding filler until they were sure they completed the joint, adding filler metal until it fell off. The flame needs to be applied to the base metals. The braze filler metal is then melted by touching it to the heated joint. The molten braze filer metal will not bond to the parts to be joined unless they are hot enough. That is a fairly basic, but profound, concept. Focus your training effort on that.

If you are going to revise your braze training program, the first thing is to make sure safety is addressed. I recommend starting by consulting ANSI Z49.1, *Safety in Welding, Cutting and Allied Processes*. It does a great job of covering the things to be concerned about in oxyfuel processes. After safety, you should instruct the brazers in the expected conduct of their jobs, getting familiarized with their work areas, process paperwork, components to braze, and the like. This is quite a bit of information and it doesn't leave a lot of time for braze training. Don't try to make them experts, at least not right away. Focus on the fundamentals. Regarding the drippings and general overuse of braze filler metal, showing them proper heating will go a long way toward solving these problems.

There is a great deal of brazing training available in the industry and I would recommend you tap into it. Much of it, however, deals with things like the metallurgy of brazing, the design of braze joints, etc. There is absolutely nothing wrong with teaching the brazers on your line about these subjects but you have a more acute need. Your brazers cannot do anything about joint designs, selection of base metals, selection of filler metals, and the like. You certainly should listen to their input about these matters, but what they really need is training in how to properly heat parts and how to add filler metal.

When talking to line brazers, you need to focus on the basics. There is general agreement on what the fundamentals are. There is some variation depending on who you talk to but basically it comes down to these:

1. Joint clearances and joint design
2. Prebraze cleaning
3. Assembly and fixturing of components
4. Fluxing
5. Heating the parts and adding filler metal
6. Postbraze cleaning

Your focus with your line brazers should be on items 4 and 5.

In summary, I suggest you do the following:

1. Provide training with an emphasis on proper heating and adding of filler metal. Even without seeing them in action, I would guess that the torches are set too hot. People like to hear the torches hiss. It is assumed that a hotter flame means a faster production rate. To achieve a hotter flame you crank up the oxygen. Increasing the oxygen results in an oxidizing flame. The best results in brazing, however, are achieved with a reducing flame. It also results in a less oxidized part, improving the aesthetics of the assembly and assisting the braze alloy flow. Refer to Fig. 2.

The following is taken from AWS *Guidelines for Hand Soldering Practices:*

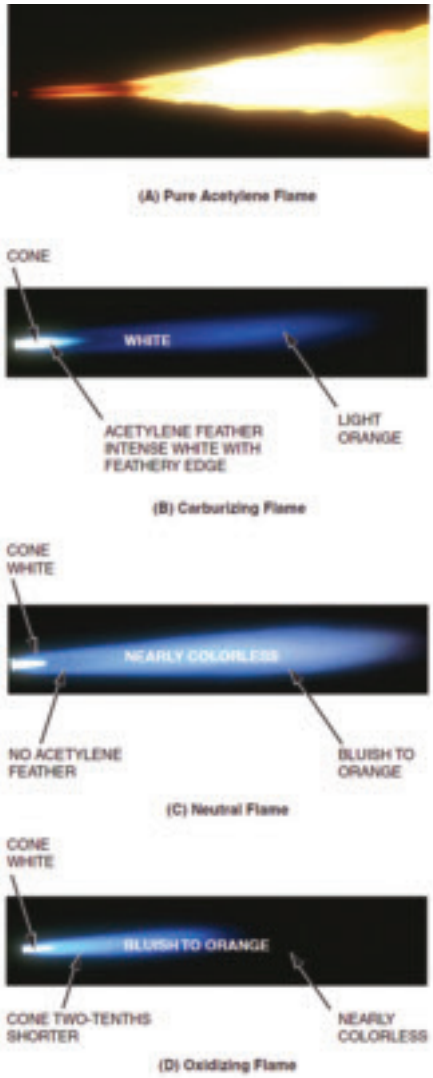

Fig. 2 — Acetylene flame color guide. From the AWS Guidelines for Hand Soldering Practices.

- Heat the parts, not the filler metal.
- Train the brazers to recognize what the proper amount of heat is. Overheating or underheating most likely will result in an unsatisfactory joint.
- Touch the filler metal to the heated parts to flow the filler metal.
- Only add sufficient filler metal to fill the joint. Any filler metal outside the mating surfaces of the joint is an unnecessary expense and serves no purpose. Significant cost savings can be achieved by reducing the amount of filler metal used.

2. Standardize brazing variables throughout your plant.

Set all torches to the same fuel gas and oxygen flow rates.

Utilize the same torch tip style for each brazer. Different joints may require different torch styles and tips.

Ensure that the proper braze alloy is selected for each joint design and clearance and that it is used consistently in all brazing areas.

Ensure that the form of filler metal (rod cross section and length) is consistent among operators and departments.

3. Introduce equipment as it makes sense.

Infrared sensors can be used to let the brazer know when the proper brazing temperature has been reached. Some devices are available that feed the filler metal once a predetermined brazing temperature is reached.

You can cut your braze filler metal consumption by making sure the brazers do not overfeed a joint. Wire feeders that dispense consistent amounts of braze filler metal can be used to remove the decision regarding how much braze alloy to add from the brazer.

Units to control the flow rates of the fuel gas and the oxygen can be used. These can be locked out to prevent the operator from changing the settings.

Or you can change from an oxyfuel process to an alternative method. Handheld induction units are available. Induction can be controlled very precisely to take the heating variable out of the control of the brazer.

There is no simple answer to how to make a manual torch brazing process more consistent. The ideas listed here may apply to some joint designs but not to others. There are, however, a number of things you can introduce to the operation and plenty of resources available in the industry to help.◆

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.

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