HVAC&R Skills Workshop

MODULE 111

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MITSUBISHI ELECTRIC
AIR CONDITIONING SYSTEMS

Skills summary

What?
A guide to silver brazing or hard soldering, including joint preparation, basic brazing procedure and recommendations for designing joints.

Who?
Especially relevant for anyone involved in the installation and maintenance of air conditioning and refrigeration systems, but also more widely applicable to general HVAC technicians.

SILVER BRAZING

One of the best methods of connecting parts together in a refrigeration system is to use welded (brazed) joints. This type of joint is used to connect tube to tube, or tube to fitting. It is leakproof, permanent and gives maximum strength.

The silver-brazed or hard-soldered joint is used extensively in refrigeration work. Silver brazing incorporates the use of a high-silver-content welding rod and appropriate flux. This type of brazed joint can be used to join copper to copper, copper to brass, and brass to steel; these are all common types of joint used in refrigeration systems.

PULLOUT

SILVER BRAZING

Silver brazing can be easily done if the correct procedure is followed. The main points to remember are:

1. Clean the joints mechanically.
2. Fit the joint closely and support it.
3. Apply the flux to match the silver brazing alloy if required.
4. Heat evenly to the recommended temperature.
5. Apply the silver brazing alloy as directed.
6. Cool the joint properly.
7. Clean the joint properly and thoroughly.

The heating of the joint must be done very carefully, directing a greater amount of heat to the largest piece being brazed.

Carbon dioxide or nitrogen should be circulated through the refrigeration system during any soldering operation on a complete mechanism to prevent an explosion.

Caution: Never use a refrigerant or compressed air.

The flux behaviour is the best way to determine the temperature of the joint as the heating progresses. The flux will dry out, the moisture (water) will boil off at 100°C and then the flux will turn milky in colour. Next, it will bubble at approximately 315°C; following this, it will turn into a clear liquid at about 600°C. This temperature is just short of the brazing temperature. The brazing alloy itself melts at 610°C and flows at 620°C.

SBA 245 (dark blue tip) is a free-flowing, low-temperature alloy which is commonly used in the refrigeration industry for joining dissimilar metals. A suitable silver brazing flux should be used with this alloy.

NOTE

To minimise the effects of oxidisation on the prepared parts of the joint, the flame from the heating torch should cover the joint throughout the brazing operation.

Other types of brazed joints

A silver-brazed joint requires a lot of careful preparation to ensure the joint is perfectly clean. This often causes problems when working in the field on old equipment. Because of this, and because of the cost of the silver alloy brazing rod and the necessity of using a flux that could cause corrosion, most brazing is now carried out using either:

- phos copper or
- SBA 115 – 15 per cent silver brazing alloy brazing rod.

Neither of these types of brazing material requires the use of a flux when brazing copper and copper-base alloys. Phos copper has a melting point of 715°C and a tensile strength of 370MPa.

The 15 per cent silver brazing alloy material has lower melting point (645°C–700°C) and a higher tensile strength of 700MPa. The advantages of the lower melting point and higher tensile strength of the silver brazing alloy brazing material results in its wide use in refrigeration work.

NOTE

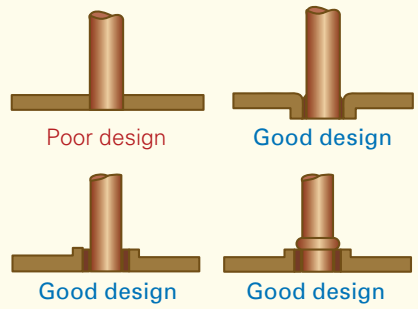
Phos copper, SBA 102 and SBA 105 have adequate joint strength but, because of their low silver content, have low ductility. This makes them unsuitable for applications where frequent straining or bending is encountered – for example, where temperature variation causes expansion and contraction of the tube.

JOINT PREPARATION

The parts of the joint to be brazed must be made to fit accurately and must be clean.

The parts must have contacting surfaces of sufficient size, for example a tube sliding into a fitting (not a press fit), to obtain a strong joint. The contacting surfaces need not be very large (three times the thinnest section is sufficient). If the parts are dented or out of round, these faults must be corrected before the brazing operation is started. The parts must be supported securely during the operation so no movement takes place.

Tube-to-plate joints



Tube-to-tube/fitting joints

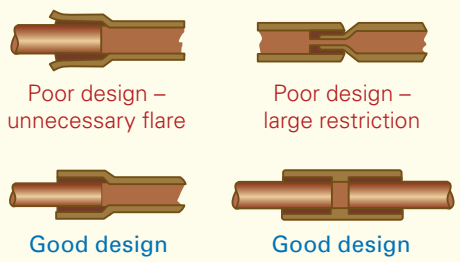


Figure 1: Some recommended designs which may be successfully silver brazed.

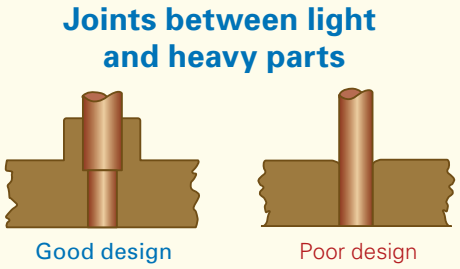


Figure 2: Some recommended designs which may be successfully silver brazed.

Procedure

1. The outside of the tubing ends and inside of fitting sockets must be thoroughly cleaned down to the bare metal. The tubing is pointed downwards to prevent entry of particles (Figure 3).

Fig 3 : Cleaning tubing ends and fitting sockets.

2. Apply a thin layer of suitable flux to the entire outside contact surface of the tubing. If too much flux is used, some will run into the tubing where it will contaminate the system.

The function of the flux is to:

- protect the weld from oxidation during heating
- dissolve the oxides present on the piping
- reduce the surface tension of the brazing alloy in relation to the metal on which it flows, enabling the molten brazing metal to "wet" the surfaces.

3. When all fittings and sections of tubing are ready to be brazed, they should be assembled, securely locked into position, firmly supported and properly aligned so that the tubing is correctly placed within the fitting (Figure 4).

There should be a uniform but thin clearance space all around, as the strength of the brazed connection depends on the thickness of the brazing alloy in the space.

The thinner the layer of filler materials, the stronger will be the joint.

Figure 4: Tube joint prepared for brazing.

4. Air must be eliminated from the tubing by passing dry nitrogen gas through the tube during and after welding until it has cooled. This prevents oxidation (black scale) inside the tubing, which naturally would act as a contaminant in the system. The nitrogen should be allowed to flow quickly enough to displace the air that is in the tubing and parts.

Figure 5 illustrates the connection of the dry nitrogen gas cylinder to a coil that is to be brazed.

NOTE The pressure of a dry nitrogen cylinder is approximately 14,000kPa. No cylinder should be used without a pressure-regulating valve.

5. Light the oxyacetylene torch and adjust for a neutral flame.

6. Apply heat to the joint, keeping the torch in constant motion as shown in Figure 6.

7. Continuously move the flame back and forth until both pieces are evenly heated, and apply alloy at the point where the tube enters the socket.

8. Continue feeding the brazing alloy into the joint until a continuous fillet is formed outside the end of the expanded tube.

9. Clean the joint with a damp cloth and inspect.

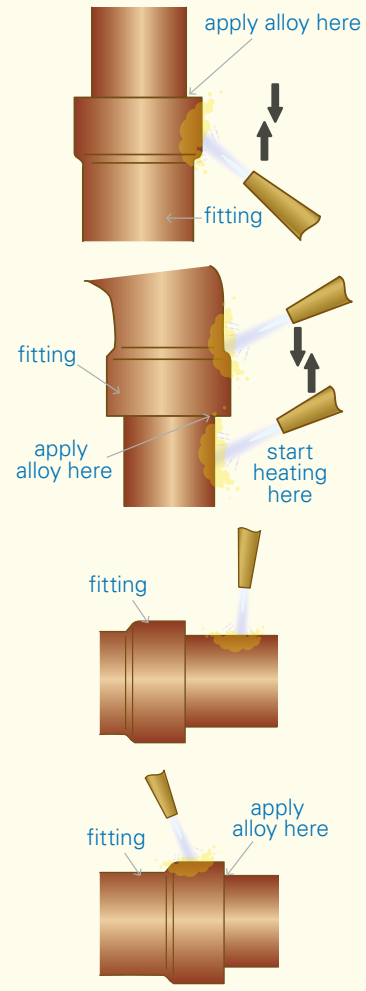


Figure 6: Applying heat to joint.

Figure 5: Venting with an inert gas.

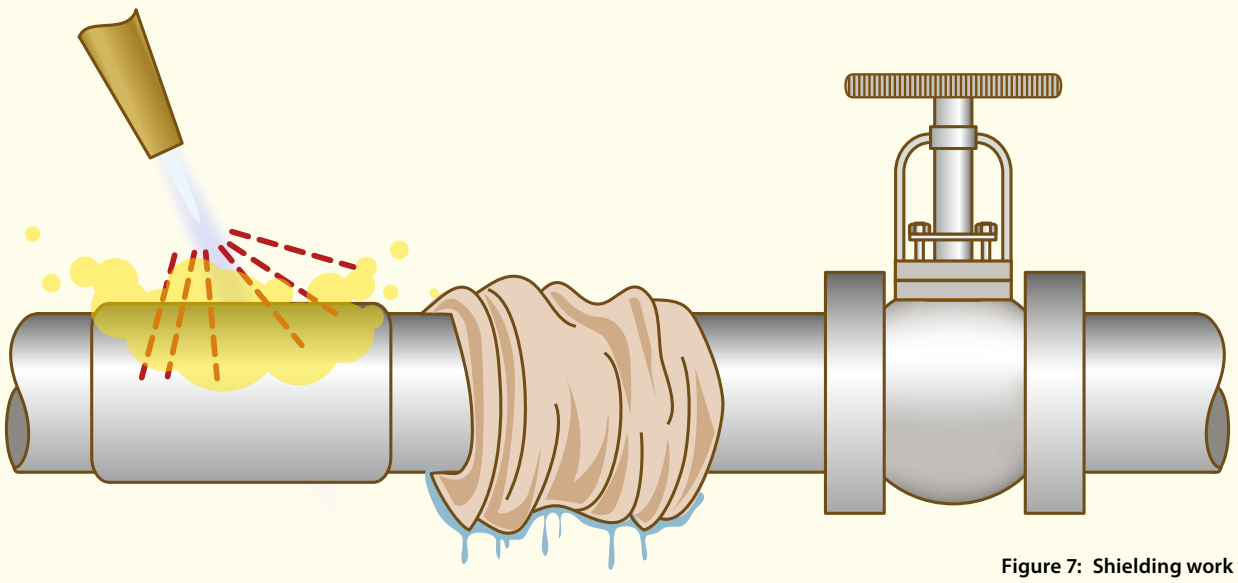


Figure 7: Shielding work with a wet cloth.

It is necessary to thoroughly wash and scrub the completed silver-brazed joint when flux has been used. Any flux left on the metals will tend to corrode them and residue flux may also temporarily stop a leak which will show up at a later date.

The joint may be cooled quickly or slowly. Cooling with water is permissible but caution must be taken to prevent water entering the tube or fittings if any end is unsealed. This water may be used to wash the joint at the same time. Visual inspection of the joint will quickly reveal any places where the filler rod did not adhere, but it is advisable to watch for this adherence and make any corrections during the brazing operation.

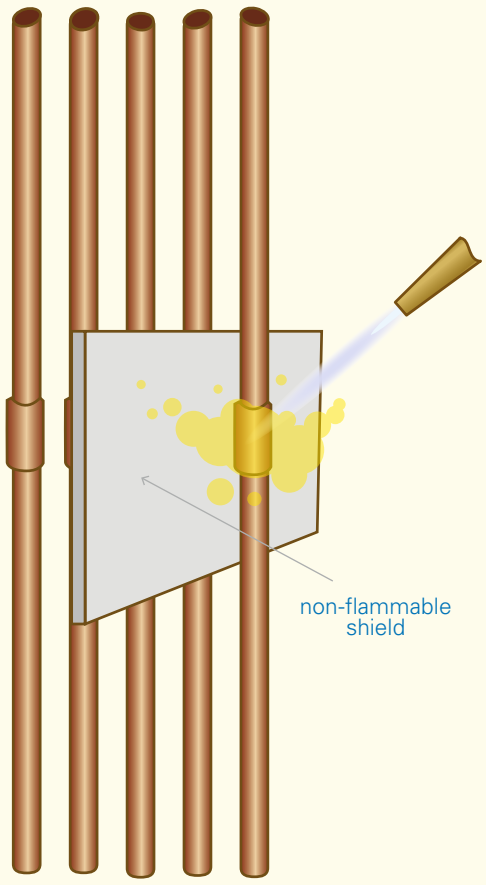


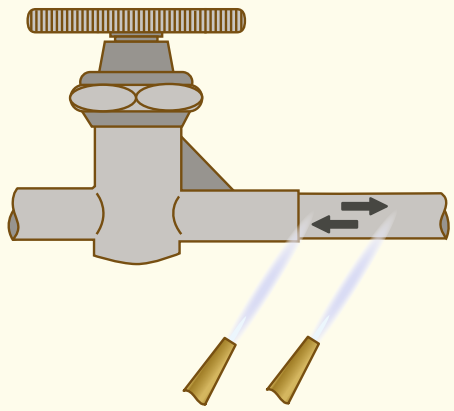
Figure 8: Shielding work with a sheet of non-flammable material.

Some tips for silver brazing

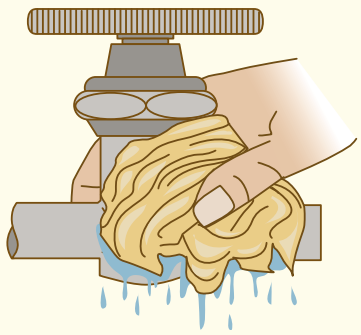
- Ensure that the working area is adequately ventilated, though not subjected to excessive draught.
- Where possible, shielding the work with a wet cloth or sheet of non-flammable material is an advantage.

Because of the high temperatures required for silver brazing, the flame should be directed away from solenoids, shut-off valves, driers and other parts which may be damaged by overheating. Heat transfer may be prevented by placing water-soaked cloths over the fittings at places where heat is not needed or by removing the parts that must be protected. Examples are shown in Figure 9.

(a) flame directed away from valve body



(b) cooling a brazed connection



(c) removing parts for protection

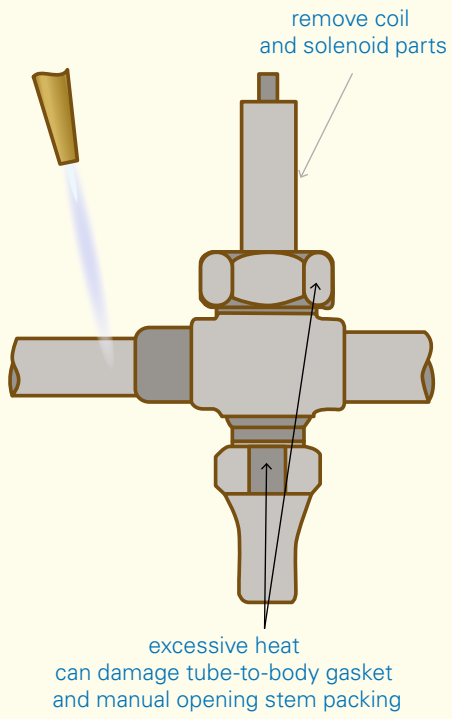


Figure 9

There are other processes used for joining metals using an oxyacetylene set as a heat source. These include soft soldering, bronze welding and fusion welding; however, use of these is comparatively minor in the refrigeration industry compared with the use of silver brazing. ■

MORE INFORMATION

This month's Skills Workshop has been taken from Australian Refrigeration and Air-Conditioning Volume 1, by Graham Boyle, F.AIRAH.

Next month:
Split system AC units – Secure fixing and safe condensate discharge