# FLUXES AND SOLDERS

Who would have thought, as we plumb into the 21st century, that there are still 'professionals' in our industry who don't know that leaded solders have been banned from use in our potable water systems since the 1980's. Unbelievable? No, it's true, at least in the case of the Yorkshire installer who risked a fine and criminal record when he recently admitted the fact to an official of Yorkshire Water!

There are non-leaded jointing solutions such as integral solder ring (guaranteed to use lead-free solder) and push-fit and press-fit fittings which do not need heat. The following is the up to date information on soldering.

## Capillary jointing systems

Copper tube and capillary fittings are manufactured to very close tolerances, so that a small but even gap results on assembly. When a clean, fluxed copper tube is inserted into a clean, capillary fitting and heated to the melting temperature of the solder used, the forces of adhesion and cohesion cause liquid solder to flow into the capillary gap. Flux enables the solder to wet, adhere to and alloy with the surface of the copper and cohesion causes sufficient solder to be drawn in to completely fill the gap so a strong, watertight joint results. Because there are a number of designs of capillary fittings and a wide variety of different fluxes, solders and brazing alloys available, reference should be made to manufacturers technical literature for advice on any particular jointing system. However, the methods of making capillary joints are similar, involving the following steps:

1. Cleaning
2. Fluxing and assembly
3. Heating
4. Finishing off

### Measuring and cutting tube

Although measuring is not strictly a part of the jointing process it can have an effect on joint quality. If tube is cut too short and does not reach the full depth of the socket a proper joint cannot be achieved. Also, if tube is cut too long the correct alignment might not result and this can also affect the capillary gap.

Always cut tube square and de-burr inside, to enable full water flow, and outside to ease entry to the fitting. Use a junior hacksaw on 6 to 10mm tube and either a rotary tube cutter or a hacksaw with a minimum of 32 teeth per inch on larger sizes. When using a tube cutter be careful not to exert too much force when tightening the cutter on to the copper tube. This can result in 'nozzling' where the end of the tube is reduced in diameter. Nozzling makes the internal burrs more difficult to remove and can affect the capillary gap making it too wide at the base of the socket.

**Note:** when making joints on soft-condition coiled copper tube it is good practice to re-round the tube end using a suitable tool so that the correct gap is maintained all round the joint.

## Cleaning

Clean the outside of the tube and the inside surface of the fitting. Fine sand paper, steel wool or brushes can be used but abrasive impregnated nylon scouring pads (similar to washing-up 'greens') are best and recommended for potable services in order to prevent particles of steel, etc, entering the system.

## Fluxing and assembly

Once cleaned the outside surface of the tube should be fluxed immediately. DO NOT apply flux to the fitting. **Only apply sufficient flux to the tube to thinly coat the mating surfaces** and assemble at once so that dust and dirt do not contaminate the capillary gap. Twist the fitting on to the tube to ensure an even coat of flux in the joint and make sure that the tube enters to the full depth of the socket. Wipe off any excess flux and the joint is ready for heating. Be sure to use a suitable type of flux for the solder used in the joint. For ordinary 'soft' soldered joints the commonly used fluxes are usually made from zinc chloride and/or zinc ammonium chlorides and some fluxes contain other active ingredients such as amines. Fluxes have to be corrosive to some extent to clean the copper and so any residues should be removed after soldering. So-called 'self-cleaning' fluxes contain free hydrochloric acid and are generally considered to be more aggressive than conventional fluxes. Whilst they are excellent fluxes, if they are employed, they should be used with extreme care and strictly in accordance with the manufacturers instructions.

## Type of solder

The function of solder is to join two metal surfaces at temperatures that are below the metals' melting point. Solder provides a metal solvent action between it and the metals being joined. This causes an intermediate alloy to be formed in the joint.

## Tin/Lead solder

Tin/lead solder alloys used to be widely used in plumbing but as legislative concern over the hazards of lead increased they have been banned from use in domestic hot and cold (i.e. potable) water systems. The change of

solder to lead-free required a flux change. The changeover caused a problem for plumbers because some traditional fluxes used for tin/lead solder would burn and char before the new lead-free alloys would melt.

## Lead-free solder

Lead-free number 23 tin / copper alloy soft solder to EN 29453 has a melting point of 230°C to 240°C and is suitable for making end feed capillary joints on all normal domestic plumbing, heating and gas systems.

## Your choice

If you do decide to or have to use leaded solder for your gas and central heating runs, then buy coils that are on different coloured plastic bobbins so that the risk of mistaken use is minimised. After all, why risk a summons and possible fine when it is so easy for anyone to check whether you have used leaded solder by simply wiping a damped piece of test paper on the suspect solder joint, which will show red if you have. However, as number 23 tin-based solder is approximately 25% less dense (so you can make more joints per 500g coil than tin/lead) and it is inherently stronger than lead-based alloys (as it has better joint strength, fatigue, and thermal cycling properties), why not use it for all your end-feed fittings?

## Method of heating

Heat is usually applied with an LPG blowtorch. Keep the flame moving until a complete ring of solder shows at the mouth of the joint on integral ring fittings. When making end feed fittings the solder should melt when it is brought into contact with the tube. The flame should then be moved away. If the solder does not melt continue to heat and then try again. Keep the flame moving, this is to prevent localized overheating which can char the flux before the solder is applied.

Only add sufficient solder to fill the capillary gap all round the tube. Any extra will simply form a bead at the bottom of the joint or possibly run inside the tube. As a guide on small tube diameters when using solder wire, a length of solder approximately equal to the tube diameter should be enough to fill the joint. Integral solder ring fittings contain just the right amount of lead-free solder. Don't add extra solder to integral ring fittings. The manufacturers have gone to great lengths to ensure that the correct amount of solder is already in the joint so adding extra to a properly prepared joint is simply unnecessary and wasteful.

## Alternatives to the blowtorch

In situations where the use of a blowtorch might result in damage to the building fabric you could consider alternative methods of heating for small diameter joints. One alternative is an electric hot air gun, especially if an attachment is used which directs the flow of hot air around the tube. This has the result of both protecting the building fabric and also speeding up the heating process. Another method is to use an electric resistance-soldering tool. This consists of a pair of heating elements fitted with interchangeable heads, which are shaped to fit the tube. These are clipped around the joint to be made and heat is generated in the joint by the electrical current and heat travels into the tube and fitting by conduction.

## Finishing off

Once the joint has been made it is important to allow it to cool so that the solder has solidified before any disturbance. It is also important to remove any residue of flux from the outside of the tube by wiping with a wet cloth and warm water. The pipeline should also be flushed with water as soon as practicable to wash out any flux residues, filings, etc. from the bore. A good cold water flush will usually remove water-based fluxes. Grease based fluxes, on the other hand, will tend to remain and a hot water flush would be better, since if fluxes are not flushed away corrosion damage can occur. If you use self-cleaning flux this flushing is even more important, and remember that gas runs aren't flushed at all, so it is vital that care is taken to prevent flux entering the tube bore!

## Plastics coated tube

When jointing plastics coated tube using capillary fittings, the plastics cover should be slit and folded back for at least 100mm and care should be taken not to allow any excess flux to run in between the tube and its plastics coating. Also, do not allow the flame of the torch to overheat or burn the plastics. Wrapping the end of the plastics and a little of the copper with a wet rag is helpful in preventing this. Once the joint has been made and any remaining flux has been removed the plastics cover can be unfolded over the tube before carefully spirally wrapping with self adhesive polythene or PVC tape to maintain the protection provided by the plastics coating. Tape should also be applied, especially to castellated plastics coated tube, at the point where the coating terminates to prevent moisture entering any gap caused by the coating disturbance or the channels in the castellated product. The tape should be wrapped over the last 25mm of intact plastics covering and at least a similar length of immediately adjacent bare copper tube too.

## Proven reliability

The capillary jointing system has been continuously evolved and improved for over fifty years to the point that capillary fittings are, in the hands of the competent, professional installer, utterly reliable. Also, the unique properties of copper tube and fittings combine to give a long, trouble-free, safe and cost-effective service life on gas, water, sanitation and heating services. So why put at risk your customers' health by using banned substances such as lead, and why risk callbacks by skimping when commissioning systems?

### Health and Safety

Potential problems associated with lead have been well researched and documented. Consequently the permitted lead level in drinking water is being reduced, under the Water Supply (Water Quality) Regulations, from the current 50µg/l to 10µg/l (i.e one-hundreth of one part per million) by 2014. Although this should pose no problems for existing solder where protective scale formation usually prevents lead being absorbed by the water, it is mandatory in new drinking water systems that only lead-free solder is used. Indeed if leaded solders are employed, the water company under the Water Supply (Water Fittings) Regulations could insists on an entire installation being replaced.