What solder?

By Roger Stephen

Model engineers frequently use solder to join two or more pieces of metal. There are a surprisingly wide variety of solders available but what solder do you use for what purpose? Soldering is a complicated business if you really get into it so this is a fairly general discussion. For more detailed help you should turn to a trusted supplier such as the very helpful people at CUP Alloys or a manufacturer such as Johnson Matthey. Other suppliers are available! For our purposes solders fall into two groups: hard and soft. The following is a brief guide to what these solders are and what they are used for.

Hard solder

For thousands of years something called 'brazing spelter' has been used for joining metal in a process known as brazing. Spelter, a hard solder, is basically a type of brass soldering material (an alloy of copper and zinc) which uses borax as a flux. It works OK but it does require a very high temperature as it melts in the range 870 to 900°C or so, and if the thing you are brazing is made of brass you risk melting that too. For that reason it is little used these days, model engineers favouring instead the range of much more convenient silver bearing solders which have replaced it.

Silver solder is a type of hard solder and, rather confusingly, the act of silver soldering is widely referred to as brazing. I will refer to it here simply as soldering. Silver solder is what you should be using for structural joints on anything non-ferrous that carries or contains steam or hot water at high pressure. This means copper boilers, steam fittings (brass and bronze), fitting cones on pipes for steam unions, and anything you need to join that is going to get hotter than perhaps a couple of hundred degrees Centigrade. You might also use it for making any joints that need to be very strong, including mild steel and stainless steel items. Silver solder used to contain cadmium but that has been eliminated from modern solders and resulted in the old familiar solders being replaced with modern versions with different names. The technical data which follows is taken from The Model Engineer's Handbook by Tubal Cain (2nd edition) and the CUP Alloys website.

For general soldering you would generally use the old silver solder called Easyflo No 2 if you still have some. It had a melting range between 610 and 620°C and on copper, brass, bronze and mild steel you would use Easyflo flux with it. The modern equivalent to Easyflo No2 is known as 455 (melting range 630 to 660°C). If you are working with stainless steel you really need a different, more aggressive flux called HT5 or, if you have it, the old Tenacity flux. I have had success in soldering the stainless handles on my firing irons using ordinary Easyflo flux but would not recommend it for structural work.

If you want to solder two joints close together in separate stages, with skill and care you can do both joints with the same solder by heating the second joint until the solder only just flows. This is because, for sound metallurgical reasons, the solder in the first joint made melts at a slightly higher temperature on the second heating. In this way it is apparently entirely possible to assemble an entire copper boiler using only one type of silver solder. However, a somewhat less nail biting way, often called step brazing, is to use a higher melting point solder for the first joint, such as Silverflo 40 (melting range 650 to 710°C) or the modern equivalent 438 (melting range 650 to 720°C) and then the lower melting point Easyflo No2 or 455 for the second joint. If you really need three stage soldering use 418 or 424 (melting range roughly 750 to 800°C) solder with HT5 flux for the first joint, then 438, and finally 455. Be careful not over-cook the highest temperature in case you start to melt the parent metal.

Soft solder

Soft solder, as its name suggests, is not as strong as hard solder and it melts at a lower temperature than hard solder. It may be found on boilers for steam 'toys' which run at relatively low pressures but for general model engineering purposes it should not be used on steam fittings, etc, and under no circumstances may it be used for structural joints on boilers. Nonetheless, soft solder has many uses in

model engineering and modelling in general. Like hard solders they also come in a range of types for a variety of purposes and they have their own fluxes, although the most commonly used flux is 'Baker's Fluid' or an equivalent. They were once basically lead/tin alloys, in varying ratios and with other metals added to give different properties but the use of lead bearing solders is now heavily restricted in some applications, notably in food and drink industries. This restriction does not apply to the hobby of modelling, however, lead free solders can be perfectly suitable for our work. The following will not discriminate between leaded and lead free soft solders.

Soft solders come with a wide variety of melting ranges and it is important that a suitable solder is selected for your application. Let us start by explaining why, quite apart from the fact that that it is soft, soft solder is unsuitable for structural joints on copper boilers.

In the rarefied atmosphere at the top of Mount Everest water boils at about 70°C – which is why they say you can't make a decent cup of tea up there! Down near sea level water boils in your kettle at 100°C and the tea is somewhat better. However, under pressure in our miniature locomotive boilers at 80 psi it boils at 160°C. Ordinary (e.g. electrical or tinman's) soft solder melts at about 180 to 190°C which is a bit too close for comfort to the temperature of our locomotive boilers so you cannot use it for that application. However, there is a soft solder that does have limited applications on our boilers – none of them of course being structural. That is a high temperature soft solder under the trade names of 'Comsol' and CuPSol.

Comsol/CuPSol is a silver/tin/lead alloy which melts at 296°C – well above the operating temperature of our boilers and so not likely to melt in service. It is used with Baker's Fluid or equivalent flux. As I keep stressing, it cannot be used for structural joints but it is commonly used for caulking threaded and nutted stays on copper boilers. Silver soldered joints, including those for stays, are always preferred on boilers but where the structural load is taken mechanically it is permissible to use Comsol to seal, or caulk, the joint. In this case the structural load is taken by the copper or bronze stay and the nuts or nipples screwed onto each end of it. The Comsol is only there to stop the nuts coming undone and the joint leaking. If you are forced to fix a firedoor hinge to the backhead with screws it is OK to solder the screws in using Comsol so they cannot come loose and to seal the threads (although it would be better to fit blind mounting bushes with silver solder if possible).

I have heard of model engineers tinning the entire surface inside the firebox with Comsol on the basis that it forms a layer which is more resistant to corrosion from combustion gases than plain copper. I have found no reference to this practice in literature or on the internet so I cannot say whether it is true or not. I was once told by our former boiler inspector, the late David Saunders, that former club member Jim Stafford did this on all the locomotives he built and they ran with no trouble for many years.

When model engineers make their own copper boilers they often find that when it is completed they end up chasing small leaks with silver solder and every time they reheat it the stress of heating causes a new pin hole to start leaking somewhere else. Eventually, in consultation with your club boiler inspector, it may be wise to stop chasing the leaks with silver solder and consider using Comsol to seal the last few pin holes. You and the boiler inspector must of course be satisfied that the silver soldered joints are all structurally sound before you do this. Of course, the down side of Comsol here is that once you have used it on a boiler you cannot then do any future repairs that require silver solder.

Another common use for soft solder is the assembly of brass plate-work such as cabs, tender tanks, side tanks, running boards, etc. These will not get very hot and soft solder is much easier to use than silver solder as the lower temperatures involved means there is far less risk of distortion. With care, using two or three solders with different melting temperatures allows stepped soldering as well for assembling in separate stages – much like stepped brazing described above.

Model boat kits often come with fittings consisting of brass items and white metal castings. Likewise, rolling stock and locomotive kits for the smaller railway scales often have etched brass sheet components and white metal parts. Soft solder is eminently suitable for assembling these. Carr's Modelling Products produce a specialist range of soft solders with melting points from 243°C down to an amazingly low 70°C, together with special fluxes to go with them. The 70°C one means that if your assembly goes horribly wrong you can chuck it in boiling water and it will fall apart so you can start again, although the parts will still be covered in solder. Once again, using solders with different melting points means stepped soldering is possible but you do need to control the temperature very carefully to avoid melting previously made joints.

So there you have it: my view of what solder to use for what purpose. Finally, may just say if you are working on a boiler and are not sure what solder to use please do talk to your boiler inspector. After all, he will ultimately pass or fail your pride and joy and you don't want to end up with a boiler you cannot run.

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