

Ask Jon Eakes

Does your soldering job leak? Why is lead-free solder hard to work with? And new products to make life easier.

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They took the lead out...

Several years ago, throughout North America lead was removed from the solder used for making joints in copper pipes intended for carrying drinking water, just as before that we had removed lead from paint. Lead based solder is still available in stores for other tasks, simply because it is a good solder that is very easy to use. But for plumbing, we have lead-free solder.

If you are like me, you once felt competent at making plumbing joints that didn't leak, and then more recently you find yourself with those little pin-hole like leaks coming through the soldered elbows. Oh that is frustrating, especially when we were once competent masters. What has happened. Simply put, the new solder requires different working techniques, even different tools than the old solder.

What has gone wrong?

If you cut open a well soldered plumbing elbow, you will see a nice continuous line of solder between the two pieces of copper.

The second photo shows a joint that will leak. Here we made a joint using the old techniques but with lead free solder and then took it apart. If you look closely inside the elbow just below my finger nail you will see a small path where the copper has no solder coating. What happened here is that the soldering flux that was applied after cleaning the piece was burned off before the solder got to this surface. When the flux burns off, the copper oxidizes and the solder doesn't stick.

You must get the solder in before the flux burns off!

The key to the whole problem is in this chart. The grey line shows how leaded solder works. It is in its solid form until heated to a certain temperature. Then very quickly it transforms from solid, to soft, to liquid. The line on the bottom shows when the solder flows as a liquid. Towards the right side of the chart there is the large vertical blue zone. This is the temperature zone where the flux will simply burn off and be gone. When working with leaded solder, you have the whole temperature range between when it first becomes liquid and before the flux burns off to work with it. This is the temperature and time zone where you touch the solder to the copper and it is drawn into the joint by capillary action, displacing the flux as it goes and attaching itself permanently to the copper nice and evenly.

Lead free solder reduces your working range.

Now look at the green line, which shows how lead free solder works. It has to get hotter before it begins to melt, and then it is much slower to move from solid, through the soft stage, to the liquid stage. There is very little room left once it is liquid before the flux burns off. Hence with lead free solder you need to get it hot very fast and get the solder into place almost instantly so that it can flow over the flux rather than arrive where the flux has already burned off and left an oxidized copper surface that the solder will not stick to.

In the TV show we visited George Brown College's plumbing school in Toronto to study all of this. They were using an acetylene torch for their work. A small precise and very hot flame. The problem at home is that we all have little Propane torches for plumbing. I am surprised to see that they are still advertised in the stores as being for plumbing, but the fact of the matter is that standard propane doesn't get hot enough to allow us to do a good job all the time. Leave the propane for cooking and lights, we need better for plumbing. One exception might be the UltraBlue torch that has hospital grade propane in the smaller aerosol cans and a very good mixing head -- it gets hotter than most propane torches. Probably the closest we can come to the professional acetylene torch in a home workshop would be to replace our propane tanks with Propylene gas tanks, which are easy to find.

MAP gas used to serve this purpose but is no longer available. Propylene has taken its place as the gas that is hotter than propane while not as hot as acetylene. In addition you can get better torch heads that because of the way they mix the air, will make that same gas even hotter. So a good torch with Propylene gas is the best starting point to getting good solder joints in plumbing all the time.

Soldering steps

Of course you have to clean off both copper surfaces and use flux for lead free solder, but you probably already knew that. The other key is to apply the blue tip of the flame so that it is just in contact with the copper, and play it back and fourth between the pipe and the elbow, heating both evenly and quickly. Touch the solder to the OPPOSITE side of the pipe to see if it will flow. When it does flow, pull away the torch and touch the solder quickly to most of the joint. When it is the right temperature, it will draw the solder all the way into the joint, all around the joint. If you have created a blob of solder on the bottom of the joint, just pass your wire of solder over the blob immediately and that will pick it up onto the solder, hence no waste.

Wipe off the flux

Two other tricks I learned at plumbing school. Wipe off the excess flux with a rag before moving on. Leaving the flux in place can eventually cause corrosion on the pipe. And remove the burr.

Remove the burr

This photo shows why you need to remove the burr on the inside of the pipe after you cut it to length. I bet you thought that it wouldn't bother anything inside the pipe, since the pipe slides neatly into the joint whether you deburr it or not. The pointer indicates where a burr was left. The red arrow shows where the inside of the pipe wall is wearing away, leading to an eventual leak. It is wearing away just down stream from the burr because the burr creates turbulence in the water flow causing the water to apply constant abrasive pressure just a fraction of an inch beyond the burr.

New Flux to prime the surface as you heat

As products change, we need to verify if we need to change how we work with them. Now I am good at soldering again, after I went back to school. But the products keep on changing. Oatey has brought out their No. 95 Tinning Flux. This is a flux for lead free solder that has silver solder powder added to the flux so as you heat the flux, the copper gets what they call "pre-tinned" or primed. This prevents the oxidation of the copper as the flux burns off and before the solder arrives, which is especially useful for unskilled plumbers or skilled plumbers working on large copper pipes. Then Lenox has brought out their Lenox Sterling solder which melts at a lower temperature than other lead free solders, opening up that time frame for working that is illustrated in the chart above.

The miricle of Cold Spray Gel

LA-CO Cool Gel Heat Barrier Spray is a great thermal shield Gel found on Amazon or Worthington Cold Coat Gel Spray found at Canadian Tire online. This is a spray gel that can protect wood from the plumbing torch, or prevent heat from moving down the copper pipe -- and that protects rubber washers that are close to your soldering job or even blocks the loss of heat to water in the pipe a foot away. In this photo you can see the gel on the plywood with absolutely no burn marks from the flame which is only an inch away. You can leave the gel to eventually evaporate. Products like this help us to solder quickly and safely with good results, keeping the heat where we need it.

We used to protect wood with asbestos sheets -- now replaced by fireproof cloths that do a good job but are difficult to position, especially as in this photo where one pipe goes through wood. The gel is a replacement, better than the sheets it has replaced.

By the way, do always have a fire extinguisher right on hand when soldering around any wood. Such a precaution could have saved many a building.

Three alternatives to soldering copper

If you would like to stick with copper pipe but not solder you now have three choices: compression fittings (which can be difficult to get just tight enough to not leak but not so tight as to distort) -- "O" ring grip fittings like Sharkbite and the and a real unknown product, a copper bonding agent. That's

right, do copper joints just like you do ABS joints! There is now a copper cold weld bonding agent designed to eliminate all soldering, is NSF approved, exceeds the strength of solder and it actually works. Check out Just For Copper available in most renovation centres.

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