

## What you should know about Brazing

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When doing brazing, the parent material is not melted as in welding but brought to the bonding temperature. The bonding temperature is when the brazing alloy melt and flow out and bind to the surface of the base material. The binding will to a large extend be a mechanical bonding. A clean surface with sufficient flux is necessary to make this happen.



Without the flux to suspend water vapour, grease and oxides, a film will prevent the brazing alloy from getting sufficient bonding. The function of the flux is therefore to dissolve impurities, detach them from the surface and the rod, and keep them in suspension. The composition of the flux must be matched to type of brazing rod. The flux liquefy approx. 100°C (212°F) before bonding temperature. Flux consist mostly of borax, also known as sodium borate, sodium tetra borate, or disodium tetra borate. It is a mineral, and a salt of boric acid. It can be in powder form consisting of soft crystals that dissolve easily in water or as a ready mixed liquid paste.



Flux coated brazing rods



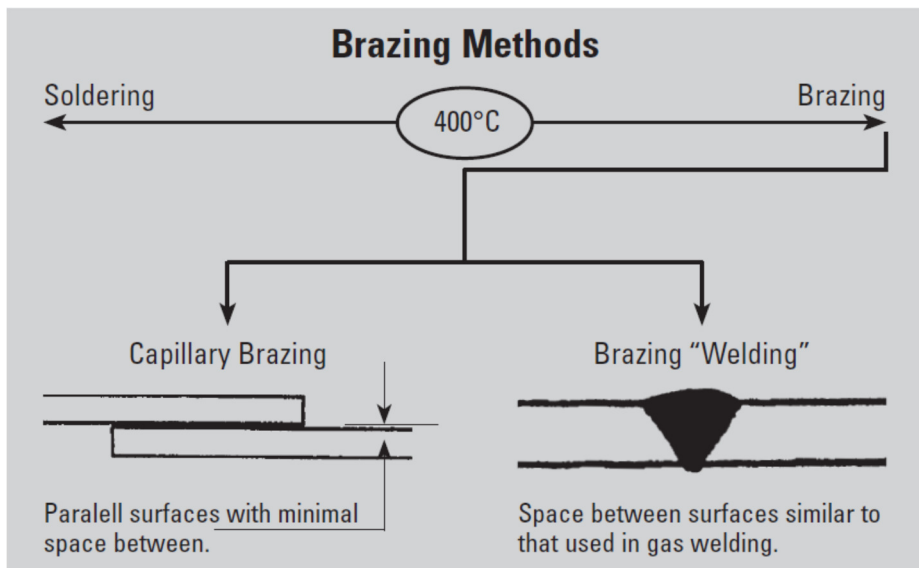
Sealed Flux container



Re- sealing insert for use after opening

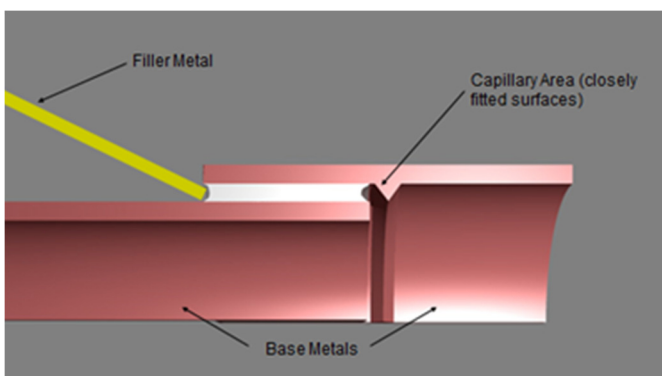
## Type of Brazing

If the bonding temperature is below 400°C (752°F), we refer to it as Soldering or Soft Soldering. If the bonding temperature is above 400°C (752°F) we refer to it as Brazing or Hard Soldering. Brazing/Hard Soldering can again be divided into Capillary brazing and Braze Welding. Capillary brazing is sometimes referred to as Silver Brazing or Phosphor Brazing. The process requires a joint consisting of two parallel surfaces forming a capillary joint. The alloys used are thin flowing. Braze welding requires joints similar to welding. The alloys used are thick flowing and can bridge large gaps.



Braze welding is the use of a bronze or brass filler rods coated with flux to join steel or copper alloys. The rods consist mostly of Copper (Cu) and Zinc (Zn) and sometimes a small amount of Silver (Ag). The name comes from the fact that no capillary action is used and that the welding technique is very similar to welding.

Capillary brazing, sometimes known as silver soldering, is brazing using a high amount of silver-based filler. These silver alloys consist of many different percentages of silver and other metals, such as copper, zinc, cadmium and phosphorus. For capillary brazing to be successful, one depends on the capillary process that allows thin flowing alloys to flow into the joint between two metal parts.



A suction force is created in a capillary joint that can be measured in millibars. The ideal opening is 0.03 to 0.08 mm (0.0012 to 0.0031") for the best capillary action and joint strength. However, in some brazing operations it is not uncommon to have joint clearances around 0.6 mm (0.024"). In capillary brazing, its only strength is what gets in between the two parallel surfaces. Cleanliness of the brazing surfaces is also important, as any contamination can cause poor wetting (flow).

### Capillary brazing alloys:

Product	Cu	P	Ag	Zn	Sn	Si	Cd	Work temperature. °C ( Solidus- Liquidus )	Tensile strength	DIN 8513	Application
AG-45-253 AG-60-252*	30 21		44 55	Bal. Bal.	2,5			730 ( 680- 740 ) 60 650 ( 630- 660 ) 30	480 Mpa 490 MPa	L-AG 44 L-AG 55Sn	Ferrous and non-ferrous metals. *Seawater alloys
Ag 5 Ag 20 Ag 25	55 44 41		4 20 25	Bal. Bal. Bal.		0,2 0,2		860 ( 840- 880 ) 40 810 ( 710- 815 ) 105 780 ( 680- 795 ) 115	350 Mpa 450 MPa	L-Ag25	Ferrous alloys
Ag 30 Sn Ag 34 Sn	36 36		30 34	Bal. Bal.	2 3			740 ( 650- 750 ) 100 710 ( 650- 720 ) 70	510 Mpa 500 MPa	L-Ag30Sn	Ferrous alloys and copper alloys
Ag 12 Cd Ag 20 Cd Ag 30 Cd Ag 34 Cd Ag 38 Cd	50 40 28 22 21		12 20 30 34 38	Bal. Bal. Bal. Bal. Bal.			7 15 21 20 22	800 740 ( 600- 760 ) 160 680 ( 600- 690 ) 190 640 ( 607- 702 ) 95 630 ( 605- 650 ) 45	410 Mpa 380 Mpa 410 Mpa 400 Mpa 400 MPa	L-Ag20Cd L-Ag30Cd L-Ag34Cd L-Ag	Ferrous and non-ferrous metals. Not for drinking water. Hazardous fumes if overheated.
Ag 2 P Ag 5 P Ag 15 P	91,5 89 80	6,5 6,3 5,4	2 5 15					710 ( 643- 824 ) 181 710 ( 643- 796 ) 153 710 ( 643- 779 ) 136	250 Mpa 250 Mpa 250 MPa	L-Ag2P L-Ag5P L-Ag15P	Copper alloys. If flux also copper alloys.

Cu: Copper, P: Phosphor, Ag: Silver, Zn: Zink, Sn: Tin, Si: Silicon, Cd: Cadmium

### What is important to remember:

When brazing seawater pipes like York Albro and Cunifer always use Silver brazing alloys with more than 50% silver. If less, the seawater will corrode the alloy away very quickly. Manufacturers of Cunifer pipes recommend from 50- 60 % silver used in brazing rods for Cunifer.



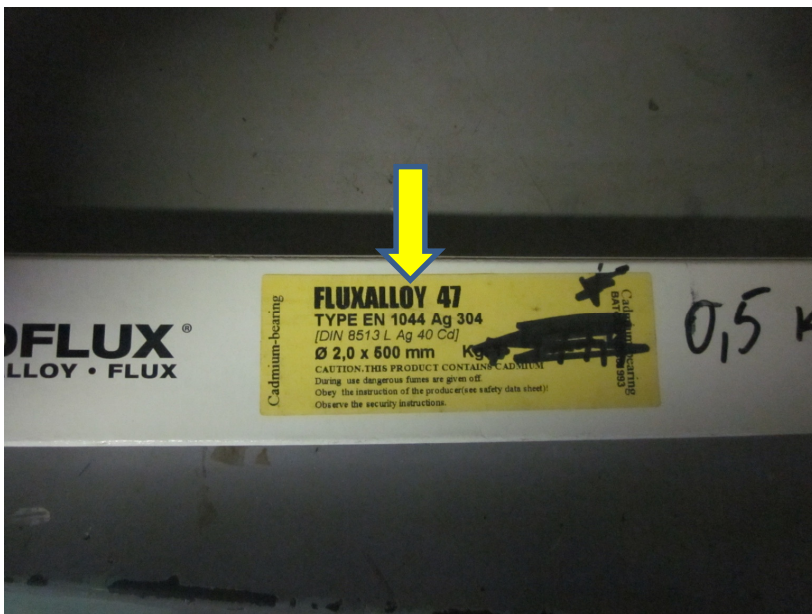
AG-60 252 is a flux coated cadmium free, seawater resistant, high strength silver rod for seawater piping. Silver content 55%. Product no. 233601  
When used on Cunifer pipes use together with:  
AG 60/45 Flux 252 PF Product no. 778461  
When used on York Albro pipes use together with:  
ALBRO FLUX 263 PF Product no. 604371

On seawater pipes, do not use Phosphor brazing rods.

## Cadmium in Brazing /Hard Solder rods:

The inclusion of Cadmium (Cd) in brazing consumables has three related advantages: It reduces the alloys bonding temperature, it shortens the duration of the brazing process and it lowers the cost of brazing. With other words, it have the same effect as silver, and is less expensive than silver. This are tempting many manufacturers and suppliers of brazing consumables to place Cadmium alloyed brazing products on their product range.

However, Cadmium is a Heavy Metal. Its melting point is 321°C (610°F) and its boiling point 767 °C (1413 °F). It will therefore easily form metallic fumes that will react with the ambient air to form cadmium oxide. Exposure to these fumes can cause metal fever with progression to pulmonary edema (fluid in the lungs) that can lead to death. Inhalation exposure to cadmium fumes at comparatively low levels may result in serious-potentially- fatale acute effects in humans. The most commonly used cadmium brazing rods contain 25% cadmium. Cadmium can also enter a human organism trough drinking water or food where cadmium-brazing rods have been used for joining



Check that the brazing rods used onboard do not contain Cadmium.

As mentioned: Cadmium have the same influence on brazing as silver, it lowers the bonding temperature. Manufacturers are therefore tempted to use an element that is less expensive but unfortunately dangerous to the health

In Europe the use of Cadmium brazing rods are no longer allowed

According to the Commission Regulation (EU) N° 494/2011 of 20 May, 2011, using and marketing of hard solders that contain more than 0,01 weight-% cadmium was no longer allowed in the EU after 10 December 2011. This regulation is binding and valid in each EU Member State.

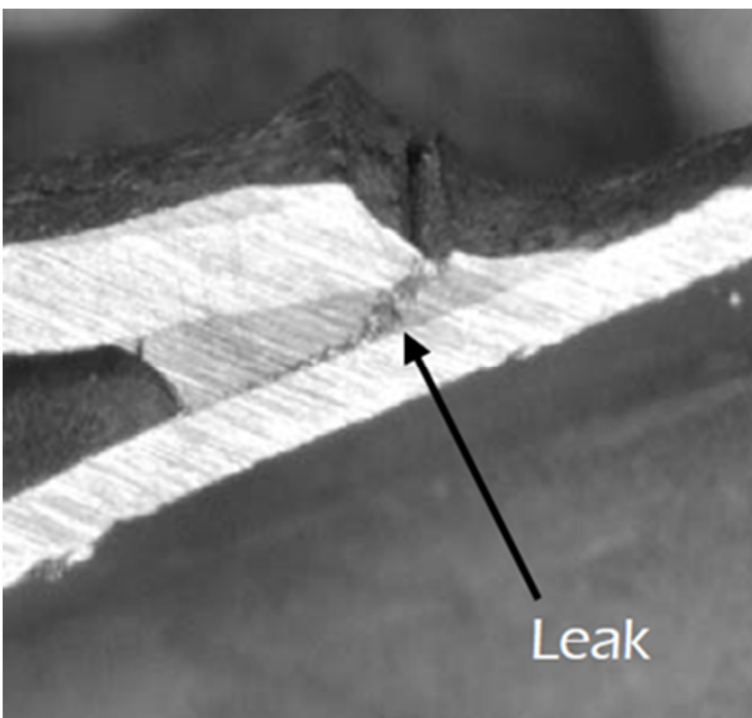
This means that from December 10, 2011 on it was no longer allowed to work with silver hard solders containing cadmium (e.g. AG306 L-Ag30Cd or AG304 L-Ag40Cd). Moreover, also the production of these hard solders was forbidden from this date on.

## Phosphor in Brazing /Hard Solder rods:

Phosphor in Brazing/ Hard solders rods are very popular when repairing refrigerants/ air-conditioned installations onboard. These refrigeration systems use copper in piping and parts like elbows and T- joint connections. Copper-phosphorous alloys are self-fluxing when joining copper to copper. That no flux is needed on copper makes them popular. The self-fluxing characteristic occurs because the phosphorous element possesses a greater affinity for oxygen than for the copper. The phosphorous also combines with oxygen in the air and the flame if an oxy- acetylene torch is used. These alloys may also be used on brass and bronze but will then require a flux. Phosphor does not decompose zinc oxide, so flux is needed for brass/ bronze.

Negative effects:

Do not use phosphor-brazing rods on copper pipes and parts used in refrigeration/ air-condition installations. R-22 consist of Chlorine, hydrogen, fluorine and carbon. It is always mixed with some mineral oil circulating inside the system. The phosphor grains are washed out of the deposit by this mixture. In a microscope, it comes out as tiny small channels in the deposit, where the phosphor have been. Result is leaks developing. An other major negative effect of phosphorous on copper is the reduction in ductility. In the range of 8.0 - 8.5% phosphorous content, the material becomes extremely difficult to form in both hot and, especially, cold forming. The phosphides segregate at grain boundaries and cause intergranular embrittlement. Avoid in environments with presence of sulphur dioxide and hydrogen sulphide. The phosphorus-rich phase rapidly corrodes in presence of sulphur and the joint fails.



Capillary brazing rods alloyed with silver will have enhanced capillary flow, improved corrosion resistance and improved strength. High silver content will reduce melting point thereby shortens the duration of the brazing process.



## Soft Solders:

Soft solder is commonly used in electronics, plumbing, and assembly of sheet metal parts. A soldering iron is the most common method to melt soft solder. Solder used for soft soldering is often found in the form of a wire that is wound on a spool. The wire has ducts filled with flux. The most common solders used for soft soldering work are 60/40 or 50/50; these numbers are based on the percentages of tin (Sn) and lead (Pb) used to make the solder. Lead is a heavy metal

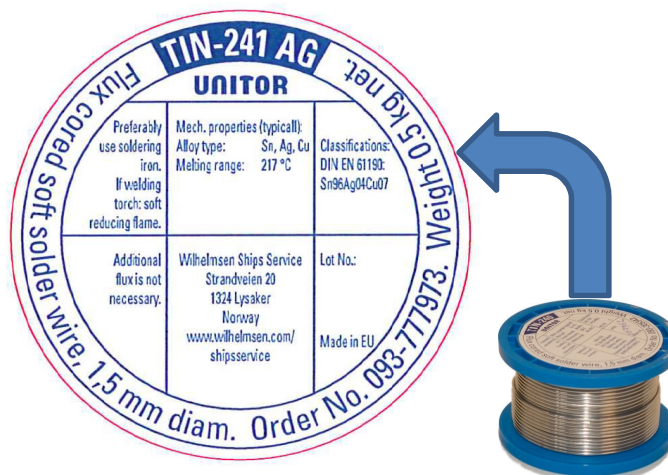
# GET THE LEAD OUT!

Important information about  
drinking water and lead



Lead containing soft solders must never be used for applications in connection with food or drinking water. On July 1, 2006 the European Union Waste Electrical and Electronic Equipment Directive (WEEE) and Restriction of Hazardous Substances Directive (RoHS) came into effect prohibiting the inclusion of significant quantities of lead in most consumer electronics produced in the EU. In the US, manufacturers may receive tax benefits by reducing the use of lead-based solder.

Lead-free solder are today available and consist of a combination of metals, with a high concentration of tin and smaller amounts of silver and copper--never lead.



TIN 241 Ag is a flux cored lead free silver alloyed soft solder. Product no. 777973

Finally for your information:

The word solder comes from the Middle English word soudur, via Old French solduree and soulder, from the Latin solidare, meaning "to make solid".