SILVER BRAZING ALLOYS

Fundamentals of Gas Welding & Brazing

Welding Technique

Successful welding depends on the following factors:

1. Selection of the correct consumables
2. Selection of the correct flame setting
3. Selection of the correct application techniques
   a) Correct angle of rod to work
   b) Correct travel speed
4. Selection of the welding preparation

Silver Brazing

Choice of Filler Metal

An alloy is normally selected for its melting and flow characteristics.

The easiest filler materials to use are the high silver, free-flowing alloys, because of their low melting temperatures and narrow melting ranges. The higher the brazing temperature and the wider the melting range of the alloy, the more difficult the brazing operation will be.

Pre-Cleaning

It is important that the mating surfaces of the components to be brazed are free from oil, grease and any surface oxide layer prior to joining. Most engineering components require nothing more than degreasing before assembly.

Oxide removal can be accomplished either chemically or mechanically. Mechanical removal is preferable, because the surface is roughened and excellent bonding is obtained. A medium emery cloth provides about the right amount of surface roughness.

Oil and grease removal is best carried out by using a solvent degreasing agent, but hot, soapy water is better than nothing at all.

Fluxing

The choice of the correct flux is just as important as the choice of filler material. There are three desirable properties of a flux:

1. The flux must melt and become active below the melting point of the brazing alloy. Borax or borax based fluxes are not sufficiently molten at the low temperatures at which silver brazing alloys are used. A low temperature fluoride based flux, such as Easyflo, needs to be employed.
2. The flux must be capable of removing the oxides found on the parent materials. Easyflo flux will remove the oxides found on most common engineering materials such as mild steel, brass and copper. Special fluxes may be required on certain types of highly alloyed steels and tungsten carbide tool tips. It is also necessary to use a specially formulated flux on aluminium bronze or aluminium brasses containing more than 2% aluminium.
3. The flux must remain active at the brazing temperature for long enough to allow the brazing operation to be carried out. Fluxes are chemical compounds which dissolve oxides formed in heating. Like most chemical compounds, a flux eventually reaches the point where it is saturated and becomes unable to dissolve any more oxide. If the flux residues appear blackened and glassy, the flux has most likely been exhausted during heating, and a flux with higher time / temperature stability should be used.

Easyflo Flux

This is the accepted general-purpose flux for use with all low-temperature silver brazing alloys that have brazing temperatures not exceeding 800°C. It will successfully flux all the common engineering materials, and its residues are soluble in hot water. Where difficulty is encountered when removing residues, immersion in 10% caustic soda is suggested.

Flux Application

The best way to apply a flux is to paint it onto the joint as a paste before assembly. It is common to see operators heating the rod end and dipping it into the flux, and then applying both to the joint. This 'hot rodding' technique has the disadvantages that the flux does not protect the joint during the heating cycle and that the limited amount of flux applied does not allow alloy penetration into the capillary gap.

If a flux powder is used, it should be mixed to a double cream consistency with water and a few drops of detergent. It should also be applied to the joint by means of a paint brush. Too much flux will rarely result in a bad joint, but too little flux will invariably give joints of poor quality.

Heating the Joint and Applying the Alloy

When heating a joint for brazing, it is essential that it is slowly and evenly heated to the brazing temperature.

The type and size of flame used will depend on the parent materials and the mass of the components. Oxy-acetylene, air-acetylene and air-propane are commonly used, but care should be taken with the first due to the high flame intensity, which may melt the parent materials.

If the mass of metal is very large, more than one torch should be used to raise the components to temperature before the flux becomes exhausted.

As a temperature guide, either the colour of the metals or the condition of the flux may be used. The flux on a joint that has reached the correct temperature for brazing should be clear, fluid and flow over the joint area like water.

When the brazing temperature is reached, the filler metal is applied by touching the joint gap with the rod and applying some indirect or splash heat from the torch to the parent material. The molten filler metal will follow the heat from the flame as it is directed along the joint. The brazing alloy should be applied according to its flow characteristics; an alloy with free-flowing characteristics should be touched at one point on the joint, from where it will flow into and around the joint by capillary action. A less free-flowing alloy should be applied along or around the entire joint, building up a fillet of alloy.

If phosphorous bearing filler rods are used, such as Eesibraze 2, the colour of the metal should be a dull cherry red before the rod is applied to the joint gap.

Once brazing has been completed, the heating should be discontinued, as excess heating may cause metallurgical problems with the parent materials and porosity in the filler materials.

When the alloy has solidified, the joint can be quenched in water to help remove flux residues.

Quenching should only be carried out when it will not damage the properties of the parent metals, or result in cracking because of stresses caused by the thermal shock (e.g. in the case of tungsten carbide pieces).

Removal of Flux Residues

The method of residue removal depends on the type of flux that has been used. Easyflo flux residues can be quite simply removed by soaking in hot water, provided they are not in a burnt and blackened condition. Complete flux residue removal is usually possible within 10 – 15 minutes of soaking in water with a temperature of 60°C or above. After soaking, the joints should be scrubbed under running water to ensure complete cleanliness.

Acid pickling is not effective in removing flux unless the residues are in a burnt and blackened condition. If pickling is necessary, it should be carried out after the flux residue removal operation.

Health and Safety

Brazing alloys and fluxes contain elements which, if overheated, produce fumes that may be harmful or dangerous to health. Brazing should be carried out in a well ventilated area with operators positioned so that any fume generated will not be inhaled. Adequate ventilation to prevent an accumulation of fumes and gases should be used. Where fume levels cannot be controlled below the recognised exposure limits, use a local exhaust to reduce fumes and gases. In confined spaces without adequate ventilation, an air-fed breathing system should be used. When outdoors, a respirator may be required. Precautions for working in confined spaces should be observed.

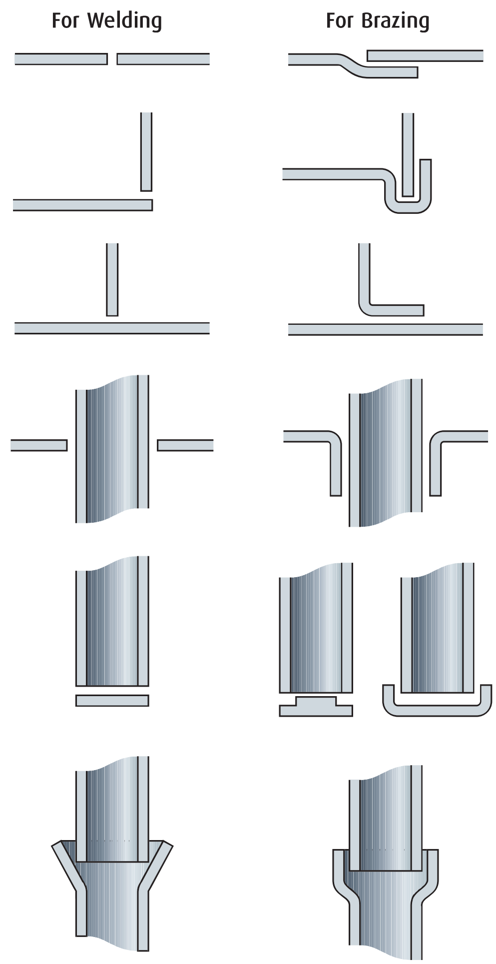
Apart from fume hazards, flux can be irritating to the skin and prolonged contact should be avoided.

Before use, read all the manufacturer's instructions, refer to the warning labels on the packaging and ask your employer for the Materials Safety Data Sheet (MSDS). You can obtain the MSDS by referring to our website at www.afrox.com or by calling 0860 020202.

Joint Design

The best brazed joints are those which have a capillary joint gap into which the molten filler metal can flow. A comparison of the different joint designs used in welding and brazing is shown below.

Typical Designs



The most common type of joint used for brazing is the lap joint, or the sleeve joint in the case of tubular components. To design a good lap joint, two criteria should be considered:

1. The joint gap
2. The degree of overlap

It is these two parameters that determine the ultimate joint strength, rather than the properties of the filler metal.

A correctly designed brazed joint will often be stronger than the parent materials from which it is constructed.

The best degree of overlap for a brazed joint is 3 – 4 t where t is the thickness of the thinnest parent metal part that makes up the joint.

The general rule for tubular parts is that the overlap should be one pipe diameter for sizes up to 25 mm diameter tube.

The most suitable joint gap depends mainly on the flow characteristics of the filler metal. The joint gaps for the various alloys listed in the following section have been indicated. The gaps quoted are those that should be present at the brazing temperature, the cold clearances being adjusted as necessary to account for any difference in the expansion properties of the parent materials.

Gas Welding

Welding Techniques

The heat generated by an oxy-fuel flame is used to melt the parent metal in the joint forming a weld pool. If a filler rod is to be used, it must also be melted into the weld pool. The flame envelope also protects the molten weld pool and the end of the filler rod from atmospheric contamination.

The weld is continuous and progresses at the speed at which the parent and filler materials can be melted to form the weld pool, but fast enough not to allow the weld pool to burn through the component creating a hole.

The filler rod, if used, is constantly fed into the weld pool at the rate required to give the correct bead width, depth of penetration and reinforcement height for the application. The length of the weld will dictate how much filler rod is required. Usually more than one length of rod will be needed and, when a new length of rod is needed, a stop and re-start will have to be effected. Stop-start can affect the quality of the weld if care is not taken to ensure the weld pool is free of contamination and enough time is given to allow the weld pool to become fully molten.

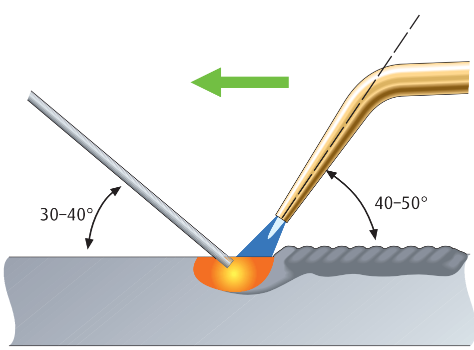
There are three recognised gas welding techniques used. These are:

- Leftward welding
- Rightward welding
- All position rightward welding.

Leftward Welding (or Forward Welding)

Leftward welding is the most common technique used in gas welding. In this technique, the flame follows the filler rod along the joint of the weld and, with the torch in the right hand, the movement is from right to left or from left to right if the torch is held in the left hand.

Leftward Welding Technique

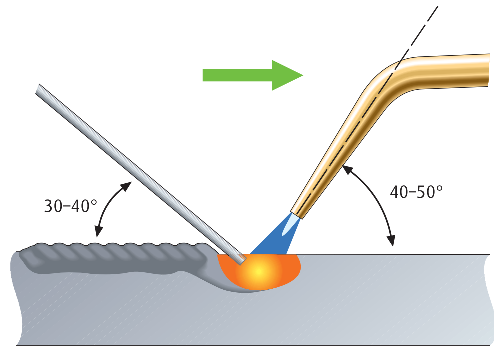


This technique can be used in all welding positions. The method is the same, with the flame following the filler rod, irrespective of the welding position.

Rightward Welding (or Backhand or Backward Welding)

With this technique, the filler rod follows the flame along the joint of the weld. With the torch in the right hand, the movement is from left to right and the opposite when the torch is in the left hand. Rightward welding is limited in its uses and is only used in the flat (1G, PA) position and for material thicknesses between 4 -16 mm thick. When welding butt joints of between 4 - 6 mm, no edge preparation is required. For thicker materials up to 16 mm, edge preparation will be required. However, it is possible to complete this joint in one pass.

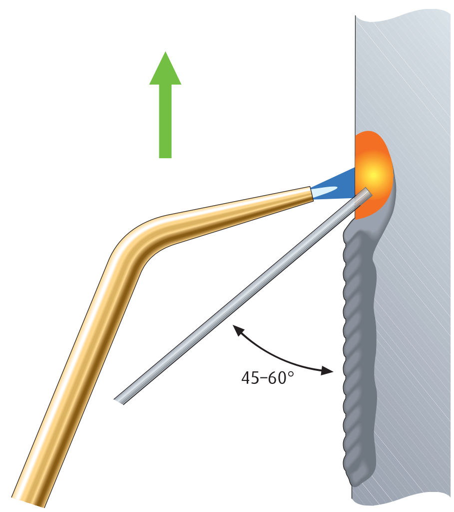
Rightward Welding Technique



All-Position Rightward Welding (APR)

With this technique, the wire can follow, precede or be in line with the flame, depending on the welding position used. The all-position rightward technique is for welding thicker materials in the vertical-up, vertical-down, horizontal-vertical and the overhead positions.

All-Position Rightward Welding Technique



The technique is mainly used for gas welding pipe of all diameters and wall thicknesses up to 6 mm in a single pass, with no edge preparation to the material. This technique was developed to compete with manual metal arc welding and is used mainly on construction sites for welding, heating and ventilating pipe-work.

Warning

Brazing can give rise to excessive noise, eye and skin burns due to the flame and its radiation, and can be a potential health hazard if you breathe in the emitted fumes and gases.

Brazing should be carried out in a well ventilated area, with operators positioned so that any fume generated will not be inhaled. Adequate ventilation to prevent an accumulation of fumes and gases should be used. Where fume levels cannot be controlled below the recognised exposure limits, use a local exhaust to reduce fumes and gases. In confined spaces without adequate ventilation, an air-fed breathing system should be used. When outdoors, a respirator may be required. Precautions for working in confined spaces should be observed.

Apart from fume hazards, flux can be irritating to the skin and prolonged contact should be avoided.

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Silver Brazing Flux

Product	Item Number	Working Range (°C)	Classification DIN 8511	Flux Form	Pack Size	Characteristics	Residue Removal
Easyflo Flux	W001852	550 - 800	F-SH1	Powder	250 g jar	-	-

Uncoated Cadmium-Free Silver Brazing Alloys

Product Name	Item Number	Diameter (mm)	Pack Size	Application	Classification	Chemistry (%)							Melting Range (°C)	Tensile Strength	Optimum Joint Gap (mm)
						Mn	Ag	Cu	Zn	Sn	Si	Ni			
Silverflo 55	W001055	1,5	100 g	The Silverflo range of cadmium-free alloys represents the ultimate safety precautions against cadmium fume. Cadmium content is controlled to 0,025% max. and the use of these alloys is highly recommended - for some applications it is obligatory, e.g. food handling equipment.	DIN L-Ag55n BS AG14	-	55	21	22	2	-	-	630 - 660	390 MPa	0,05 - 0,15
	W001056	1,5	1 kg												
	W001058	3,0	1 kg												
Silverflo 40	W001170	1,5	100 g		BS AG20	-	40	30	28	2	-	-	650 - 710	450 MPa	0,075 - 0,20
Silverflo 30	W001030	1,5	100 g	Silverflo 55 is the lowest melting point alloy in the group and has been widely adopted as a substitute for Easiflo1and Easiflo 2. Silverflo 40 is a general purpose alloy suitable for use on most engineering materials. Silverflo 30 is an economic alloy mainly used to braze copper and mild steel. Alloys with less than 25% silver are widely used on copper and steel. They give a good colour match on brass but require close temperature control due to their high melting points. Due to their relatively short melting range, these alloys are suitable for step brazing.	BS AG16	-	30	38	32	-	-	-	695 - 770	505 MPa	0,075 - 0,20
Fridgebraze Bare	W001561	1,5	2 kg	Fridgebraze was specially developed to overcome liquid embrittlement when brazing galvanised steel pipes used in the refrigeration industry.	-	1,1	24,5	39,6	34,2	-	0,4	0,2	670 - 730	470 MPa	0,075 - 0,20
	W001562	2,0	1 kg												

Flux Coated Cadmium-Free Silver Brazing Alloys

Product Name	Item Number	Diameter (mm)	Pack Size	Application	Classification	Colour Code	Chemistry (%) Mn	Ag	Cu	Zn	Sn	Si	Ni	Melting Range (°C)	Tensile Strength	Optimum Joint Gap (mm)
Fluxcoat 402	W001197	1,5	100 g	Fluxcoat 402 is a general purpose alloy suitable for use on most engineering materials.	BS AG20	Yellow	-	40	30	28	2	-	-	650 - 710	450 MPa	0,075 - 0,2
	W001180	1,5	Sleeve													
Silvercoat 30	W001031	1,5	100 g	Silvercoat 30 is an economic alloy mainly used to braze copper and mild steel. Alloys with less than 25% silver are widely used on copper and steel. They give a good colour match on brass but require close temperature control due to their high melting points.	-	Light Yellow	-	30	38	32	-	-	-	695 - 770	505 MPa	0,075 - 0,2
	W001032	1,5	1 kg													
Silvercoat 18	W001018	1,5	100 g		-	Blue	-	18	45,75	36	0,25	-	-	785 - 815	470 MPa	0,075 - 0,2
	W001019	1,5	1 kg													