ador WELDING

# e-Weldone

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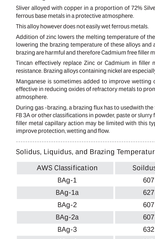
## BRAZING WITH SILVER BASE FILLER METAL

Silver–base filler metals are used extensively for brazing both ferrous and non ferrous metals and alloys except Aluminium & Magnesium. These filler wires consist of various additions of Copper, Zinc, Cadmium, Tin, Manganese, Nickel and Lithium.

Silver brazing alloys are generally used where high levels of strength and resistance to shock are required.

Some examples of Silver brazing applications are joining of band saws, shrouds and lacing wire for turbine blades and in application involving fabrication of equipment where appearance and strength are important.

Silver brazing alloys usually contain varying percentages of silver, copper and zinc and are often called silver solders. These compositions with melting points in the range of 700 to 800 deg. Care much lower than copper brazing rods with melting points in the range of 870 to 1090 deg. C.



### Selecting Silver Fillers Metals

Silver alloyed with copper in a proportion of 72% Silver, 28% Copper formsa eutectic at 780 Deg C.This filler (BAg–8) is used to furnace braze non-ferrous base metals in a protective atmosphere.

This alloy however does not easily wet ferrous metals.

Addition of zinc lowers the melting temperature of the silver-copper binary alloys and helps wet iron,cobalt and nickel. Cadmium is also effective in lowering the brazing temperature of these alloys and assists in wetting a variety of bases metals However, Cadmium oxide fumes generated during brazing are harmful and therefore Cadmium free filler metal should be be utilized wherever possible.

Tincan effectively replace Zinc or Cadmium in filler metals.Nickel is added to assistin wetting tungsten carbides and provide greater corrosion resistance. Brazing alloys containing nickel are especially recommended for joining stainless steels as they reduce susceptibility to interfacial corrosion.

Manganese is sometimes added to improve wetting on stainless steel andother nickel-chromium alloys containing cemented carbides.Lithium is effective in reducing oxides of refractory metals to promote filler metal wetting and improve flow on stainless steels when furnace brazed in protective atmosphere.

During gas -brazing, a brazing flux has to usedwith the filler metal/brazing rodto deoxidise the base metal surface. Mineral fluxes conforming to AWS FB 3A or other classifications in powder, paste or slurry form are generally used. Vapour flux introduced through a torch flame also is suitable although filler metal catalogues may be limited with this type of application.Vapour (gas) flux is normally used as a supplement to mineral flux types to improve protection, wetting and flow.

### Solidus, Liquidus, and Brazing Temperature Ranges of Silver based filler metals

| AWS Classification | Solidus,°C | Liquidus, °C | Brazing Temperature Range, °C |
|---|---|---|---|
| BAg-1 | 607 | 618 | 618-760 |
| BAg-1a | 627 | 635 | 635-760 |
| BAg-2 | 607 | 702 | 702-843 |
| BAg-2a | 607 | 710 | 710-843 |
| BAg-3 | 632 | 688 | 688-816 |
| BAg-4 | 671 | 779 | 779-899 |
| BAg-5 | 663 | 743 | 743-843 |
| BAg-6 | 688 | 774 | 774-871 |
| BAg-7 | 618 | 652 | 652-760 |
| BAg-8 | 779 | 779 | 779-899 |
| BAg-8a | 766 | 766 | 766-871 |
| BAg-9 | 671 | 718 | 718-843 |
| BAg-10 | 691 | 738 | 738-843 |
| BAg-13 | 718 | 857 | 857-968 |
| BAg-13a | 771 | 893 | 893-982 |
| BAg-18 | 602 | 718 | 718-843 |
| BAg-19 | 760 | 891 | 877-982 |
| BAg-20 | 677 | 766 | 766-871 |
| BAg-21 | 691 | 802 | 802-899 |
| BAg-22 | 680 | 699 | 699-830 |
| BAg-23 | 960 | 970 | 970-1030 |
| BAg-24 | 660 | 750 | 750-843 |
| BAg-26 | 705 | 800 | 800-870 |
| BAg-27 | 605 | 745 | 745-860 |
| BAg-28 | 649 | 710 | 710-843 |
| BAg-33 | 607 | 682 | 682-760 |
| BAg-34 | 649 | 721 | 721-843 |

BAg-1

Brazing filler metal has the lowest brazing temperature range of the BAg filler metals.Because of this, it flows freely into tight capillary joints. Its narrow melting range is suitable for rapid or slow methods of heating.This filler metal also contains cadmiumand toxic fumes may be formed when it is heated.Precautions must be taken to assure proper ventilation of brazing area to protect brazing personnel.

BAg-1a

Brazing filler metal has properties similar to Bag-1 with slightly higher Silver content.Either composition can be used where low temperature, free-flowing filler metals are desired. This filler metal also contains cadmium and fume hazards must be eliminated.

BAg-2

Brazing filler metals,likeBAg-1 is free flowing and suited for general purpose work. Its broader melting range is helpful where clearances are wide or not uniform. This filler metal contains cadmium and fume formed during brazing are toxic and hence care must be taken as per safety precautions.

BAg-2a

Brazing filler metal is similar to BAg-2, but is more economical than BAg–2 since it contains 5% less silver. This filler metal contains cadmium and fumes formed on heating are toxic and hence safety precautions are to be followed.

BAg-3

Brazing filler metal is a modification of BAg 1a with nickeladdition. It has good corrosion resistance in marine environment and caustic media and when used on stainless steel, will inhibit crevice (interface) corrosion. Because the nickel content in it improves wet ability on tungsten carbide tool tips, the largest use for this filler is to braze carbide tool assemblies. Its melting range and low fluidity make this filler suitable for brazing larger fillets or filling wider clearances. This filler metal contains cadmium.

BAg-4

Brazing filler metal, like B Ag 3, is used extensively for carbide tip brazing, but flows less freely than BAg-3. This filler metal does not contain cadmium.

BAg-5 and BAg-6

Are filler metals frequently used for brazing in electrical industry. They are also used along with BAg-7 and -24 in the dairy and food industries where the use of cadmium containing filler metal is prohibited. BAg-5 is excellent filler metal for brazing brass parts (such as in ship piping, hand instruments or lamps; Since Bag-6 has broad melting range and is not as free flowing as BAg-1 and -2, it is a better filler metal for filling wide joint clearances or forming large fillets.

BAg-7

Brazing filler metal, a cadmium free substitute for BAg–1, is low melting with good flow and wetting properties. Typical applications include:

1) Food equipment where cadmium must be avoided
2) Minimising stress corrosion cracking in nickel base alloys at low brazing temperatures.
3) Improving colour match where the site colour blend with the base metal

BAg-8

Brazing filler metal is suitable for furnace brazing in protective atmosphere without use of flux as well as for procedures requiring flux. It is usually used on copper or copper alloys. It can also be used on stainless steels, nickel base alloys and carbon steels, although it's wetting action on these metals is slow. Higher brazing temperature will improve flow and wetting.

BAg-8a

Brazing filler metal is used for zinc in protective atmosphere and is advantageous when brazing precipitation hardening and other stainless steels in the 760 to 870 Deg C. The lithium content serves to promote wetting and to increase the flow of filler metal on difficult to braze metals and alloys. Lithium is particularly helpful on base metals containing minor amounts of titanium and aluminium.

BAg-9 and -10

filler metal are used particularly for joining sterling silver. These filler metals have different brazing temperatures and so can be used for step brazing of successive joints. The colour, after brazing approximate the

BAg-13

Brazing filler metal is used for service temperature up to 370 Deg C. Its low zinc content makes it suitable for furnace brazing.

BAg-13a

Brazing filler metal is similar to BAg-13 exept that it contains no zinc which is advantageous where volatilization is objectionable in furnace brazing.

BAg-18

is similar to BAg-8 in its application. Its tin content helps promote wetting on stainless steels, nickel base alloys and carbon steel.

BAg-20

Brazing filler metal possesses good wetting and flow characteristics and brazing temperature range higher than the popular Ag-Cu-Zn-Cd composition. Due to its good brazing properties, freedom from cadmium, and a more economical silvercontent, new uses for this filler metal are being developed.

BAg-21

filler metal is used in brazing of AISI 300 and 400 series stainless steels as well as the precipitation hardening nickel and steel alloys. BAg-21 is particularly suited to protective atmosphere furnace brazing because of absence of zinc and cadmium. It doesnot require a flux for proper brazing unless the temperatures are low.

BAg-22

Is low temperature, free flowing fillermetal with improved strength characteristic over BAg-3 particularly in brazing tungsten carbide tools.

BAg-23

Is high temperature, free flowing fillermetal usable both for torch & protective atmosphere furnace brazing. This filler metal is mainly used in brazing Stainless Steel, Nickel base & Cobalt base alloys for high temperature applications. If this fillermetal is used in a high vacuum atmosphere- a loss of manganese will occur due to its high vapour pressure. Thus a partial pressure vacuum is desirable.

BAg-24

filler metal is low melting, free flowing, cadmium-free and suitable for use in joining low carbon 300 series stainless steel (particularly food handling equipment & Hospital utensils) and small Tungsten carbide inserts for cutting tools.

BAg-26

filler metal is low silver, Cadmium free material suitable for Carbide & Stainless Steel Brazing. The low brazing temperature & good flow characteristics make it well suited for moderate strength applications.

BAg-27

filler metal is similar to BAg-2, but has low Silver & is somewhat more subject to liquation due to wider melting range. This filler metal contains Cadmium. Toxic fumes are formed on heating.

BAg-28

filler metal has a relatively narrower melting range than other cadmium free classifications with similar silver content. It also has free flowing characteristics.

BAg-33

filler metal was developed to minimize brazing temperature for a filler metal containing 25% Silver. It has a lower Liquidus, and therefore, a narrower melting range than BAg-27, its higher total Zinc plus Cadmium content may require more highercare during Brazing.

BAg-34

filler metal is a Cadmium free material with free flowing characteristic. The Brazing temperature range is similar to that BAg-2 and BAg-2a, making it an ideal substitute for these filler metals.

The Silver copper eutectic (BAg–8) which contains 72% Silver and 28% copper, melts at 780 Deg. C and is used when zinc in the alloy would give trouble. Alloys containing silver, copper, manganese & those with a further addition of Nickel and silicon are used for similar purposes. Zinc or Zinc and Cadmium combined with relatively high percentages of Silver provide a series of alloys that melt at temperatures between 700 and 760 Deg. C and are white colour and are used in applications where copper would be a objectionable. An alloy containing Silver Copper, Zinc and Cadmium ( BAg–1a), which flows freely at 635 Deg. C is used extensively for joining both ferrous and non ferrous metals and alloys because it makes strong joints.

Conductivity : Silver Brazing alloys have a higher electrical conductivity than base metal brazing alloys, and therefore their use is particularly desirable for brazing parts of electrical apparatus where the highest conductivity is required. Zinc tends to lower the conductivity and the Silver copper eutectic previously mentioned has about 70% of the conductivity of Copper.

Corrosion : Any of the standard Silver Brazing alloys are resistant to most of the common types of corrosion. When unusual conditions have to be met, it is desirable to make up the specimen and subject them to the actual conditions of use in order to determine the best alloy. Galvanic corrosion is a problem, but since it is generally restricted to the areas exposed to attack, a catchidic joining alloy would give the best result. Silver alloys with high percentage of Silver are cathodic to many metals & alloys used to resists corrosiveconditions. Therefore they are satisfactory for use under such conditions. They should not be used,however, for joining stainless steel when the joints are likely to be attacked by Nitric acid.

The question of colour match with different metals and alloys is often raised. Those Silver brazing alloys with low percentages of Silverare yellow and the colour becomes whiter as the Silver is increased. Alloys with high Silver & without any copper are the whitest, but in a properly fitted joint of brazing alloy which is visible is so narrow that any slight difference in colour is generally a negligible factor.

Fitting, Cleaning, and Assembling :

Silver Brazing alloys flow freely into narrow openings and clearances in the range of 0.05 to 0.10 mmshould be maintained to produce the strong joint. The surface of the joint should be clean and free from all grease, dirt and oxide scale. Any film that prevents the wetting of the joint surfaces will prevent a strong bond from being made. After removing all contaminants, the surface needs to be cleaned with emery cloth, washed with an appropriate cleaning solution or pickled with a suitable solution to remove any scale. A highly polished surface from rolling or drawing is not acceptable. A slight roughening of the surface by either mechanical or chemical means will assist in good bonding.

When joining flat members, either with lap or butt joints, it is desirable to grind or machine the surfaces of the joint so that they may be held parallel and equidistant to each other. If thin sheet inserts are used, the parts should be clamped together with enough pressure to hold them firmly together after the alloy has melted.

After the members have been properly cleaned and fitted, the joint surface should be protected with a film of flux. This flux must be fluid and chemically active at the melting point of the brazing alloy and should spread ever the entiresurface. It is alsoadvisable to protect the brazing alloy with flux when it is fed into the joint.

Borax or combinations of Borax and Boric acid are used, but specially prepared fluxes that are fluid and active at lower temperatures are available and are preferred for lower melting point alloys. These proprietary fluxes are composed of chemicals that dissolve refractory oxides readily and should be used when brazing stainless steel.

Furnace Brazing :

Furnace Brazing is extensively used with Silver-base filler metals. Either continuous or batch furnaces are used and the heating may be by electricity. The atmosphere in the furnace is controlled to prevent oxidation by the use of various types of reducing or non oxidizing gases.

A considerable amount of brazing is done with induction & resistance heating.

Dip Brazing :

Dip Brazing is another successful method of brazing. The metal bath type of dip Brazing is principally used for dipping small parts like terminal wires. Salt bath brazing has been applied to different types of assemblies where the Silver Brazing alloy can be pre placed, and the component parts jigged in a satisfactory manner.

Gas Brazing :

Gas brazing includes all combinations of torch brazing, such as oxy-Acetylene, Oxy Hydrogen, Oxygen & natural gas and butane or Propane; also air with these fuel gases. The air-gas & air-acetylene torches will produce satisfactory results with small parts and the large torches or those with multiple flames may be used on fairly large work pieces.

Precautions :

In order to obtain the full benefit from these low temperature silver brazing filler metals, the operator should be trained to observe the rate at which different metals become heated to the brazing temperature and to give particular attention to the relative mass of each of the members being brazed. Metals of high heat conductivity, such as copper, should be preheated some distance from the joint. If there is much difference in the size of the parts, then the one with largest cross section should be given the most heat.

Applications:

Electrical :

Transformer leads and taps are brazed with Silver alloys because of the low temperature at which strong, shock resistant joints of high conductivity can be made. Joints in bus bar installations of all kinds are made with these alloys because of the high strength, corrosion resistance and elimination of voltage drop. Ground connections and cable joints are also made with this process.

In the manufacturer of electric motors, end rings are bonded to rotor bars, and many small parts in the manufacturer of electrical equipment are brazed with silver alloys. Lacing wires and shrouding are joined to turbine blades and in certain types of turbine, the blades are Silver-alloy brazed to packing pieces.

Refrigerators and Air Conditioning :

One of the largest uses of Silver Brazing alloys is in the manufacture of refrigeration unit, for both house hold and industrial plants. The low temperature at which they melt and the high corrosion resistance make them particularly desirable for joining the light metal sheets and tubing which are used in this industry.

Piping :

Standard Pipe and fittings up to 25 cm or more in diameter are joined with these alloys and tests on joints show no failure in the pipe or fitting when the work done properly. Special fitting are being made with rings of silver brazing alloy fitted into grooves cut in the fitting, and this type of joint has been specified for marine and Navy piping, and Piping in Buildings.

Other Uses :

Articles for home, such as cooking utensils, hot water tanks, water heaters and metal furniture are brazed. Industrial equipment such as chemical equipmentsd, containers, dairy equipment and innumerable products in the electrical, automotive and aerospace industries are brazed with silver-base metal fillers.

Ador welding manufactures silver-brazing rods and fluxes in the following brand names:

Silver brazing flux- Silbraze and Silver brazing rods viz;Bras 3302, Bras 3305,

Bras 3314,Bras 3323,Bras 3343,Bras 3356 with silver content varying from 2% to more than 50%.

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