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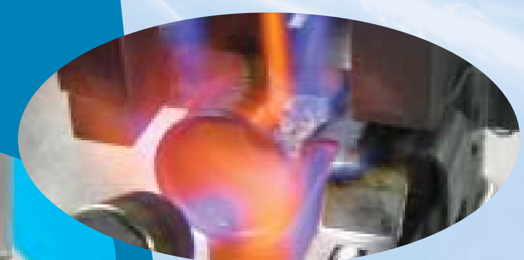
Fusion Paste Division
ISO9001:2000 Certified

Paste Brazing & Soldering Alloys



FUSION INCORPORATED

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The Fusion Paste Process

Paste Alloys

Custom blended to meet your requirements, each Fusion Paste Brazing or Soldering Alloy contains the following basic components:

- **Finely atomized filler metal,** alloyed to exacting standards for composition, melting range, and compatibility with base metals to be joined. In general, Fusion alloys conform to all accepted industry standards.
- **Fluxing agent,** designed to remove and prevent reformation of surface oxides during heating. Type and amount are carefully matched to the individual application, ensuring consistent, dependable joints with minimal flux residue.
- **Paste-like binder,** which holds flux and filler metal in stable suspension; prevents metal-flux interaction. Controlled formulation ensures consistent application and keeps paste alloy localized in the joint area.

Applicators

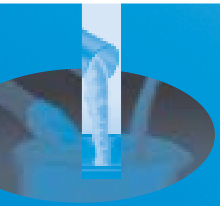
Unlike soldering or brazing alloys in other forms, Fusion Paste Alloys permit single-step application of filler metal and flux to the assembly. The paste alloy itself is stored in a pressurized reservoir, generally sized to meet production requirements for a full 8-hour shift. Fusion positive-displacement applicators may be built into high-speed production equipment for fully automatic assembly, or hand held for semi-automatic processing.

Heating

Heating may be accomplished by most conventional methods, including open flame, atmospheric or non-atmospheric furnace, infra-red, resistance or induction. At specified temperature, the liquid flux is released from the paste alloy, cleaning the joint area for maximum bond reliability. The atomized filler metal then liquifies and flows onto the newly-cleaned area, cooling to form a structurally sound brazed or soldering joint.

Total Responsibility

Among the numerous benefits of Fusion Paste Brazing and Soldering are elimination of pre-fluxing, more precise measurement of filler metal and flux, reduced costs via automation of manual steps, and more consistent joint quality through elimination of human error. In addition, Fusion's "Total Responsibility" approach ensures a coordinated effort in the manufacture of paste alloys, applicators, and equipment, plus expert system installation and service follow-up. (Request Bulletin T-101 for information on Fusion Automatic Brazing & Soldering Machines.)



Selecting a Paste Brazing or Soldering Flux

As defined in the Glossary (page 19), a brazing or soldering flux serves to remove and prevent reformulation of base metal oxides during heating. Since oxides inhibit effective "wetting" of the assembly with molten filler metal, it is important that an adequate flux be employed during the joining operation. This does not, however, preclude prior cleaning of the assembly (chemical or mechanical) to remove grease, oil, paint, and other impurities. These must be cleaned away to ensure that the flux can act directly on the metal surfaces to be joined. General criteria for flux selection are explained in this section.

Base Metals

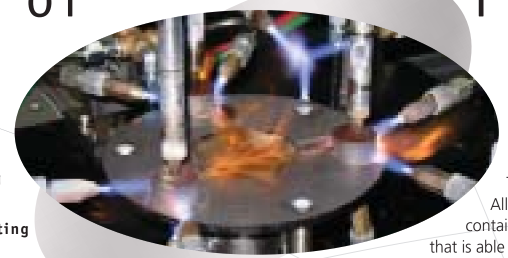
Base metal oxides vary in regard to rate of formation and tenacity. The flux selected must be capable of removing the oxides from the base metals and keep them oxide-free during heating, when oxidation accelerates.

In soldering, some metals such as aluminum, chrome, and zinc have very tenacious oxides. Oxide removal is frequently marginal on these metals even with the use of highly corrosive, acid fluxes. To successfully solder such metals, plating the surface with easily soldered materials is sometimes desirable.

Brazing of metals with tenacious oxides is often performed in a pure hydrogen or vacuum controlled atmosphere.

Residue Removal

Soldering fluxes are classified by the corrosive properties of their post-solder-ing residue. The three major flux categories are Non-corrosive, Intermediate, and Corrosive. **Non-corrosive** fluxes should be selected for applications where residue removal is impossible. Active constituents may be added to these non-corrosive fluxes for stronger fluxing action, provided they do not promote corrosion after soldering. Depending on the corrosive nature of the service environment, the residue of **Intermediate** fluxes may or may not have to be removed. If the soldered assembly is to function under normal atmospheric conditions, it is advisable to remove the intermediate flux residue, since water vapor and oxygen will accelerate corrosion. **Corrosive** fluxes should be used only when the soldering flux residue can be removed. If left on the joint, the residue will eventually attack the solder and the base metals. Most brazing flux residues are active in nature and should be removed.



Gas/Oxygen burners bring brazing filler metal to melting temperature, yielding strong carbide/steel joints.

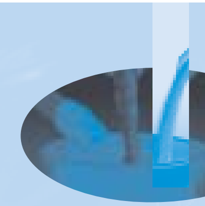
Active Fluxing Temperatures

In both brazing and soldering, the flux must be active at the liquidus temperature of the filler metal. If it is not active at this temperature, oxides will re-form and prevent a metal-to-metal bond. Active fluxing temperature range is dependent upon time and temperature. A slower heating rate increases the possibility of burning out the flux before reaching the melting temperature of the filler metal.

Joint Configuration

Individual flux-binder combinations affect the flow characteristics of paste brazing or soldering alloys.

When brazing or soldering assemblies that require the filler metal to flow a considerable distance, a free-flowing flux-binder combination should be selected. Conversely, if the paste is applied to a joint with a narrow shoulder or a vertical surface, a sluggish flux-binder combination is required to stay in place until just below the liquidus temperature of the filler metal. Since the paste flow is also a function of the filler metal, fluxes are selected which augment the flow characteristics of the particular filler metal.



Selecting a Paste Brazing or Soldering Filler Metal

Among the benefits of Fusion Paste Brazing or Soldering is the fact that the atomized filler metal may be custom alloyed or otherwise formulated to meet specific requirements. From the simplest soldering job to the most complex assembly operation, proper selection of filler metal is vital in controlling cost and performance. Included in this section are some of the criteria which will aid in proper selection.

Base Metals

The Fusion Paste Alloy used should contain a filler metal that is able to wet the base metals and be metallurgically compatible with them in order to form a strong bond.

Base Metal/Filler Metal Interaction

The degree of metallurgical interaction at the grain boundaries is a direct function of time at melting temperature. Depending upon the specific application, a high degree of metallurgical interaction between base metal and filler metal may be either desirable or undesirable. Therefore, the degree of interaction wanted should be established in advance. The two most important factors in determining base metal/filler metal interaction are heating time and filler metal melting temperature. The more rapid the heating cycle, and the lower the melting temperature of the filler metal, the less interaction occurs. The degree of interaction affects the mechanical and physical properties of the base metals as well as the joint.

Service Requirements

The filler metal selected must conform to application specifications regarding strength, both at room temperature and, if necessary, elevated or subzero temperatures. The corrosion resistance properties of the filler metal may also be important if the assembly will be subjected to moist or humid operating conditions.

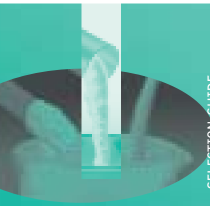
Joint Configuration

The desired distance that the molten filler metal will have to flow is an important factor in filler metal selection. Since the flow properties of filler metals differ, one must be selected that will move completely around or through the joint. These flow properties are important because paste filler metals are usually dispensed at only one point on the joint, and capillary attraction is relied on to equally distribute the filler metal throughout the joint. When brazing or soldering an unusually long or irregularly configured joint, for example, a filler metal with narrow melting range should be selected because of its free-flowing properties.

Joint Clearance

Assembly tolerances are of prime importance when selecting a filler metal. For most applications, joint clearances from .002" to .004" are optimum. A particularly tight-fitting joint normally dictates the use of a free-flowing alloy, while wide tolerances require a more sluggish filler metal that will remain in the joint area during heating. As to joint design, it should be noted that tolerances far outside the optimum range given above may impair the success of capillary attraction in distributing filler metal throughout the joint.

When brazing or soldering two dissimilar base metals, the rate of thermal expansion becomes an important factor. In such cases, the base metal component with the higher expansion rate may cause an increase or decrease in joint clearances when heated. Thus, assemblies composed of dissimilar base metals may require adjustment in tolerance to maintain desired clearances at brazing or soldering temperatures.



SELECTION GUIDE

Fusion Paste Solder Fluxes

Solder paste PWC-430-830 automatically applied to brass assembly.

Non-Corrosive Fluxes

Fluxes are classified as "Non-Corrosive" when their residue after soldering will not corrode and eventually destroy the joint if allowed to remain. Generally incorporating a rosin base, these fluxes contain mild organic acids which are neutral at room temperature but become slightly acidic upon heating. Neutral, rosin fluxes are particularly useful in electrical applications, where their non-conductive, non-corrosive residue may be safely left on the assemblies.

For applications where flux residue cannot be removed, but surface oxides require stronger fluxing action, special additives may be included to produce an "Activated Rosin" flux. The active constituents are designed to decompose at soldering temperatures, yielding a neutral flux residue. Standard non-corrosive fluxes for Fusion Paste Solder Alloys are as follows:

GPR General purpose electronics grade (RMA) formula with average restrictivity and excellent shelf-life. Hard, slightly opaque residue is non-corrosive and non-conductive, making residue removal optional.

LPS Mildly activated rosin flux, formulated specifically for electrical applications due to non-corrosive, almost colorless residue. Restrictive binder localizes paste deposit both before and after soldering. Best suited for lower temperature filler metals. (See fluxing range, page 7).

LPT A rosin flux similar to LPS with the capacity to be paired with higher temperature alloys.

MBC A very mildly activated rosin with characteristics similar to LPT and increased spread.

Intermediate Fluxes

These fluxes usually consist of mild organic salts, with considerably stronger fluxing action than non-corrosive types. Residue after soldering is normally not harmful to the soldered joint. However, residue should be removed whenever possible, as moisture in the atmosphere may initiate corrosion. Standard intermediate fluxes for Fusion Paste Solder Alloys are as follows:

WC Mild halide flux with excellent fluxing properties. At soldering temperatures, a reaction takes place which tends to neutralize the flux residue. May be used on joints with a narrow shoulder.

PMS Mild halide flux with excellent fluxing properties. At soldering temperatures, a reaction takes place which tends to neutralize the flux residue. Provides minimum slump during heating until the alloy melts.

PWC Similar to WC and PMS with residue that is readily water washable. Least hot and cold slump of the intermediate line.

PA Restrictive, activated flux which stays in place well on vertical or narrow-shouldered joints. At soldering temperatures, a reaction takes place which tends to neutralize the flux residue. Provides minimum slump during heating until the alloy melts.

PAN Restrictive, activated flux with properties similar to PA. Recommended for use with unusually low temperature solder alloys.

Corrosive Fluxes

Most corrosive fluxes contain active inorganic acids and salts. Due to their increased strength and ability to quickly remove surface oxides, these fluxes are ideally suited to high-speed, automated soldering operations. Although corrosive fluxes generally produce the most reliable soldered joints, their residue after soldering must be removed, or it will eventually attack and destroy the joint. Standard corrosive fluxes for Fusion Paste Solder Alloys are as follows:

SSE Strong, inorganic flux with excellent fluxing action on surfaces with tenacious oxides. Due to moderately restrictive flow properties, SSE may be used on most joints with a narrow shoulder.

SMH Strong, inorganic flux with activity similar to SSE. Exhibits minimal outgassing when heated. Recommended where unusually large paste deposits are used. Especially useful in long heating cycles (i.e. ovens).

WCE Active halide flux, suitable for use on most steel, stainless steel, and plated surfaces. Strong fluxing action produces extremely reliable soldered joints. Restrictive nature permits use on both vertical and narrow-shoulder joints.

Fusion Paste Solder Fluxes

Flux Type	Fluxing Range*	Suggested to Remove Residue	Flow Characteristics	Recommended For Use On: Copper Brass**	Steel	Plated Surfaces	Stainless Steel
Non-Corrosive							
GPR	300-525°F 149-273°C	Mineral Spirits or Chlorinated Hydrocarbon Solvent	Fair Spread	Yes	No	LT	No
LPS	300-525°F 149-273°C	Mineral Spirits or Chlorinated Hydrocarbon Solvent	Restrictive	Yes	No	LT	No
LPT	300-525°F 149-273°C	Mineral Spirits or Chlorinated Hydrocarbon Solvent	Restrictive	Yes	No	LT	No
MBC	450-595°F 232-313°C	Mineral Spirits or Chlorinated Hydrocarbon Solvent	Fair Spread	Yes	No	LT	No
Intermediate							
WC	300-525°F 149-273°C	Hot Water	Stays in place, little spread until molten	Yes	Mild (LT)	Most (LT)	LT
PMS	300-525°F 149-232°C	Hot Water	Stays in place, no spread until molten	Yes	Mild (LT)	Most (LT)	300 Series (LT)
PWC	300-525°F 149-232°C	Hot Water	Stays in place, no spread until molten	Yes	Mild (LT)	Most (LT)	300 Series (LT)
PA	300-450°F 149-232°C	Hot Water	Stays in place, little spread until molten	Yes	Mild (LT)	Most (LT)	300 Series (LT)
PAN	125-300°F 52-149°C	Hot Water	Stays in place, little spread until molten	Yes	Mild (LT)	Most (LT)	300 Series (LT)
Corrosive							
SSE	250-600°F 121-316°C	Hot Detergent Water	Stays in place, no spread until molten	Yes	Most (LT)	Most (LT)	300 & 400 Series (LT)
SMH	300-600°F 149-316°C	Hot Detergent Water	Stays in place, no spread until molten	Yes	Most (LT)	Most (LT)	300 & 400 Series (LT)
WCE	300-600°F 149-316°C	Hot Detergent Water	Stays in place, little spread until molten	Yes	Most (LT)	Most (LT)	Most (LT)

* Extended heating times can cause fluxes to oxidize prematurely
** Unusual service conditions may facilitate stress corrosion of certain brass parts joined with fluxes containing ammonia. Laboratory evaluation suggested
LT Laboratory testing is recommended due to widely varied metallurgical surface conditions.

Fusion Paste Solder Filler Metals

By definition (see Glossary page 19), a soldering filler metal has a melting range generally below 840°F and always below that of the base metal to be joined. As shown in the chart on page 9, Fusion Paste Solder Alloys may be blended to meet specific requirements in performance and melting range. Following are the most commonly used combinations and their particular characteristics.

Tin/Lead Paste

Tin/lead filler metals have good wetting and flow properties and can be used with non-corrosive, intermediate, and corrosive fluxes. The filler metals high in lead content are not as free flowing as the filler metals with a higher percentage of tin.

Tin/Antimony Paste

Pastes containing these filler metals retain good strength characteristics at elevated temperatures. Since their solidus temperature is considerably higher than tin/lead alloys, they are frequently specified for applications where high service temperatures will be experienced.

Tin/Silver Paste

Pastes containing these metals also exhibit better strength than the standard tin/lead series. Although slightly higher in cost, they are exceptionally free flowing and offer excellent electrical conductivity. The absence of lead makes these pastes suitable for use in food-handling vessels where lead is prohibited.

360° stripe of PWC-505-830 deposited onto copper coupling.

Tin/Lead/Silver Paste

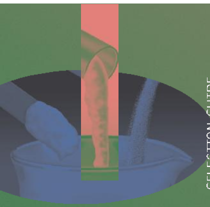
Often selected for use on silver-plated surfaces in the electronics industry. The presence of silver in the alloy improves creep resistance and reduces the tendency to scavenge silver plating from base metals.

Tin/ Silver filler metal melts at 473°F, producing leak-free joints.

Fusion Paste Solder Filler Metals

Fusion Number	Nominal Alloy Composition Sn	Pb	Bi	Other	Solidus Temp. °F	Solidus Temp. °C	Liquidus Temp. °F	Liquidus Temp. °C	Specs. ASTM-B32
136	12	18	49	21In	136°F	58°C	136°F	58°C	—
158	13.3	26.7	50	10Cd	158°F	70°C	158°F	70°C	—
165	12.5	24.95	50	12.5Cd, .05Ag	158°F	70°C	165°F	74°C	—
300	43	43	14	—	289°F	142°C	325°F	163°C	—
360	60	40	—	—	361°F	183°C	374°F	190°C	60B
361	62	36	—	2Ag	354°F	180°C	354°F	180°C	—
365	63	37	—	—	361°F	183°C	361°F	183°C	63B
440	45	55	—	—	361°F	183°C	441°F	228°C	45B
450	50	50	—	—	361°F	183°C	421°F	217°C	50B
455	40	60	—	—	361°F	183°C	460°F	238°C	40B
470	30	70	—	—	361°F	183°C	491°F	255°C	30B
490	25	75	—	—	361°F	183°C	511°F	267°C	25B
560	5	93	—	2Ag	530°F	277°C	568°F	297°C	—
570	10	88	—	2Ag	514°F	268°C	554°F	290°C	—
575	10	90	—	—	514°F	268°C	570°F	299°C	10B
595	5	95	—	—	572°F	269°C	594°F	312°C	5B
Lead-Free									
216	26	—	54	20Cd	216°F	101°C	217°F	103°C	—
281	42	—	58	—	281°F	138°C	281°F	138°C	—
430	96.5	—	—	3.5Ag	430°F	221°C	430°F	221°C	96.5TS
441	99	—	—	1Cu	440°F	228°C	440°F	228°C	—
460	95	—	—	5Sb	452°F	233°C	464°F	240°C	95TA
500	100	—	—	—	449°F	231°C	449°F	231°C	—
505	95	—	—	5Ag	430°F	221°C	473°F	245°C	—

Other alloys are available upon request.



Fusion Paste Brazing Fluxes

Fluxes for Paste Brazing Alloys have been formulated to complement automated operations where quick removal of surface oxides at high temperatures is required. Generally, brazing fluxes are highly corrosive, thus their residue after brazing should be removed. Experience has shown that "standard" flux/binders are sometimes varied to meet a particular application, however, the following fluxes are most commonly used.

Deposit of LHK-1205-650 brazing paste applied to steel bracket assembly.

STL

Very active, free-flowing flux, for use on normal ferrous and non-ferrous base metals. Can also be used on such hard-to-braze materials as cadmium-oxide and nickel-chrome. Low-temperature, fluoride compound results in excellent shelf life.

APW

Ideal for fast heat cycles, including induction, with minimum smoke generated. Use on steel, copper, and brass, yielding excellent post-braze plating properties.

STN and STK

Restrictive, silver brazing flux for use where a prolonged heating cycle or maximum activity at high temperatures is required. Excellent for stainless steel, malleable iron, and other hard-to-braze metals including carbide. Useful where brazing and heat treating operations are combined.

LHK

Fluxing properties similar to STL; somewhat more restrictive, although joint penetration remains excellent. For use with silver, copper/phos, and copper/zinc filler metals.

WSU

Very restrictive, low temperature flux that produces smooth, void-free joints. Withstands extreme temperatures and direct flame. Ideal for extended heat cycles; performs well under open flame, induction, or oven.

WSK

Like WSU, yet specially formulated for long-term stability when packaged in a syringe.

WSP

A very restrictive, low temperature flux often used on small parts or assemblies where application on a vertical surface is necessary. Recommended for use on copper, brass, and stainless steel base metals.

DMX

High-temperature, low fluoride flux with activity from 1100 to 1700°F. Very restrictive flow works best when sandwiched inside joint. Recommended for use on stainless steel and carbides.

BMW

Very high-temperature, borate flux with activity from 1600 to 1900°F. Used primarily on steel, brass and copper, with high-temperature filler metals such as brass, bronze or nickel.

BMA

Same characteristics as BMW. Flux stays in place very well on vertical joints and surfaces where gravity assist is not favorable.

Silver based filler metal flows at 1205°F throughout joint interface.

Fusion Paste Brazing Fluxes

Flux Type	Fluxing Range*	Suggested to Remove Residue	Recommended For Use With*: Silver Base Filler Metals	Copper/Phos. Copper/Silver Phos. Filler Metals	Gold Base Filler Metals	Copper/Zinc Filler Metals
STL	1000-1600°F 538-871°C	Acid or Alkaline Cleaner	Yes	Yes	Yes	No
APW	1000-1600°F 538-871°C	Acid or Alkaline Cleaner	Yes	No	Yes	No
STN/ STK	1000-1700°F 538-927°C	Acid or Alkaline Cleaner	Yes	Yes	Yes	Yes
LHK	1000-1700°F 538-927°C	Acid or Alkaline Cleaner	Yes	Yes	Yes	Yes
WSU/ WSK	1000-1700°F 538-927°C	Acid or Alkaline Cleaner	Yes	No	Yes	Yes
WSP	1000-1700°F 538-927°C	Acid or Alkaline Cleaner	Yes	No	Yes	Yes
DMX	1100-1700°F 593-927°C	Acid or Alkaline Cleaner	Yes	Yes	Yes	Yes
BMW	1600-1900°F 871-1038°C	Acid or Akaline Cleaner	No	No	Yes	Yes
BMA	1600-1900°F 871-1038°C	Acid or Alkaline Cleaner	No	No	Yes	Yes

* Filler metal selected must have a liquidus temperature within the fluxing range specified.

SELECTION GUIDE

Fusion Silver Brazing Filler Metals (BAg)

By definition, a filler metal for brazing has a liquidus temperature greater than 840°F, but lower than that of the base metal(s) being joined. Fusion paste brazing filler metals are classified on this and the following pages based on their primary metal content. Among the most widely used are silver-bearing pastes, which may be used to braze most ferrous and non-ferrous base metals – excluding aluminum, titanium, and magnesium. These filler metals have become popular in general use due to their free-flowing, ductile nature and relatively low melting range. All conventional heating methods may be used with the Fusion silver-bearing pastes shown here.

Fusion Silver Brazing Filler Metals

Fusion Number	Nominal Alloy Composition: Ag	Cu	Zn	Cd	Ni	Sn	Solidus Temp.		Liquidus Temp.		Specs. AWS A5.8
1000	45	15	16	24	—	—	1125°F	607°C	1145°F	619°C	BAg 1
1050	50	15.5	16.5	18	—	—	1160°F	627°C	1175°F	635°C	BAg 1a
1100	35	26	21	18	—	—	1125°F	607°C	1295°F	701°C	BAg 2
1120	30	27	23	20	—	—	1125°F	607°C	1310°F	710°C	BAg 2a
1130	19.5	32.5	35.5	12.5	—	—	1082°F	583°C	1375°F	746°C	—
1200	50	15.5	15.5	16	3	—	1170°F	632°C	1270°F	688°C	BAg 3
Cadmium-Free											
1115	60	30	—	—	—	10	1115°F	602°C	1325°F	718°C	BAg 18
1202	40	30	28	—	—	2	1202°F	650°C	1320°F	716°C	BAg 28
1205	56	22	17	—	—	5	1145°F	619°C	1205°F	651°C	BAg 7
1230	60	25	15	—	—	—	1260°F	682°C	1325°F	718°C	—
1235	65	20	15	—	—	—	1280°F	593°C	1325°F	718°C	BAg 9
1238	38	31	28.8	—	—	2.2	1220°F	660°C	1292°F	700°C	—
1240	40	30	28	—	2	—	1240°F	671°C	1435°F	779°C	BAg 4
1245	40	30	25	—	5	—	1260°F	682°C	1550°F	843°C	—
1246	45	25	30	—	—	—	1256°F	680°C	1292°F	700°C	—
1250	45	30	25	—	—	—	1250°F	677°C	1370°F	743°C	BAg 5
1255	55	21	22	—	—	2	1166°F	630°C	1220°F	660°C	—
1260	50	20	28	—	2	—	1220°F	660°C	1305°F	707°C	BAg 24
1265	25	41	32	—	—	2	1265°F	685°C	1400°F	760°C	BAg 37
1400	72	28	—	—	—	—	1435°F	779°C	1435°F	779°C	BAg 8
1450	50	34	16	—	—	—	1270°F	688°C	1425°F	774°C	BAg 6
1740	54	21	—	—	—	25Pd	1650°F	899°C	1740°F	949°C	—
4765	56	42	—	—	2	—	1420°F	771°C	1640°F	893°C	BAg 13a
4772	54	40	5	—	1	—	1325°F	718°C	1575°F	857°C	BAg 13
4774	63	28.5	—	—	2.5	6	1275°F	690°C	1475°F	801°C	BAg 21

Furnace Brazing with Fusion Paste Alloys

Typical assemblies joined with Fusion copper brazing pastes.

Of all brazing processes, the most variables are presented when brazing in atmosphere or vacuum. Among these are the type of base and filler metal used, type of atmosphere, dew point, temperature, and even furnace construction. Most furnace brazing pastes are supplied without flux, consisting only of atomized filler metal and a neutral binder.

Fusion offers a full line of controlled atmosphere brazing pastes for various base metals and filler metals. The filler metals include copper and copper based alloys, including copper/phosphorus based systems, silver brazing alloys, and aluminum based filler metals.

EXO

- Typically first choice for copper brazing in exo/endo atmospheres
- Minimal to no residue under broad range of part cleanliness and atmosphere conditions.
- Not recommended for H_2:N_2 atmospheres
- No hot or cold slump
- Non-spattering
- Compatible with wide range of metal concentrations
- Easily dispensed through "squeeze bottles"
- Adheres to part even after drying
- Water washable cleaning properties

CCL

- Leaves minimal to no residue
- No hot or cold slump; non-spattering
- Suitable for exo/endo atmospheres, H_2:N_2 atmospheres, and vacuum
- Compatible with wide range of metal concentrations
- Easily dispensed through "squeeze bottles"
- Adheres to part even after drying
- Ideal for vertical or "upside down" joints

CDW

- Similar to CBL with improved/reduced stringiness and less hot/cold slump
- Cleaning properties with water better than CBL, but not as water washable as EXO and CCL
- Adheres to part even after drying
- Leaves minimal to no residue. Ideal for extremely low dew point hydrogen atmosphere

CNT, CNG, CKW

- Suitable for either atmosphere or vacuum brazing
- Low ash value
- Leaves minimal to no residue where low dew points (minimum 20° or below) and high temperatures (1800°F or above) are maintained.

CBL, CBC, CFW

- Non-drying, neutral binders for atmosphere brazing
- Restrictive flow and slump properties permit use on most vertical joints
- Flow properties may be modified with additives, depending on the application.

PNP

- Recommended where dew points are marginal and furnace temperatures are in the lower (silver brazing) range
- Not recommended for use on vertical joints due to pronounced slump in both hot and cold stages.

CAP

- Suitable for use in H_2:N_2 and dissociated ammonia atmospheres with low dew points (0 to -30°F)
- Leaves no residue under these conditions
- Also suitable for use in vacuum furnaces

Fusion Furnace Paste Selection Guide

Type of Atmosphere	Filler Metal	Base Metals Joined	Recommended Binders
Exothermic and Endothermic Atmospheres	Copper (AWS BCu -1a)	Carbon Steels	EXO CCL CNG CAP CBL CDW
	Bronzes* (Various Cu-Sn Ratios)	Carbon Steels	EXO
Hydrogen – Nitrogen Mixtures including Dissociated Ammonia And Pure Hydrogen	Copper (AWS BCu -1a)	Stainless Steels	CNG CDW CCL CBL CAP
	Bronzes* (Various Cu-Sn Ratios)	Stainless Steels	CDW

* The copper/tin filler metals used for furnace brazing are frequently referred to as "low temp" in the copper brazing field.

Fusion Specialty Brazing Filler Metals

In addition to the widely-used silver brazing alloys, specialized Fusion filler metals are available to meet specific requirements for brazing. Among these criteria are joint strength, service temperatures, economy, and compatibility with the metals being joined. Classified according to their primary metal content, Fusion specialty brazing alloys are explained below and summarized in the selector charts on page 15.

Nickel-Bearing Filler Metals (BNi)

Filler metals of this type are most commonly used for their resistance to heat and corrosion at elevated temperatures. Depending on the specific composition, nickel-bearing alloys are resistant to service temperatures up to 1800°F. Although best results are obtained by brazing in a reducing atmosphere or vacuum, other heating methods are occasionally used with the addition of an appropriate flux. Nickel-bearing filler metals are most commonly used to braze stainless steel (300 and 400 Series) and nickel and cobalt-based alloys.

Copper-Bearing Filler Metals (BCu, BCuP, RBCuZn)

Pure copper and copper-bearing brazing alloys exhibit excellent strength properties – with the strength of some pure copper joints approaching that of the base metal itself. Although high temperature, "pure" copper brazing mandates the use of vacuum or reducing atmosphere, other alloyed copper compositions are suitable for open-air brazing via most conventional heating methods.

When copper is combined with zinc or tin (RBCuZn), melting temperature – and resistance to corrosion – are lowered substantially. The addition of copper oxide and/or iron oxide somewhat restricts filler metal flow, yielding improved filleting properties. When phosphorus or phosphorus and silver are added (BCuP), the resulting filler metal exhibits "self-fluxing" properties on copper base metals. These BCuP filler metals, however, should not be used on iron or nickel base metals due to the possibility of Phosphorus Embrittlement – a weakening condition caused by base metal/filler metal interactions.

Gold-Bearing Filler Metals (BAu)

Fusion pastes containing these filler metals are most often used for applications requiring high resistance to corrosion and oxidation. In addition, since these metals exhibit a very low rate of interaction with the base metal, they are often used to join assemblies having a relatively thin section. Iron, nickel, and cobalt base metals are among those which may be successfully brazed with gold-bearing filler metals.

The higher-temperature gold filler metals are used almost exclusively in the aircraft industry to meet requirements for high service temperature combined with excellent resistance to corrosion and oxidation. Generally, brazing is done in a vacuum or reducing atmosphere, without the use of flux.

Gas/Oxygen torches melt copper/phosphorus filler metal at 1256°F, sealing capillary tube joints.

Dispenser gun applies copper/phosphorus paste deposits to tube/header joints.

Fusion Specialty Brazing Filler Metals

Nickel-Bearing

Fusion Number	Alloy Composition Ni	Cr	Fe	Si	B	P	Solidus Temp.	Liquidus Temp.	Specs. AWS A5.8
1610	89	—	—	—	—	11	1610°F 877°C	1610°F 877°C	BNi 6
1630	75.9	14	—	—	—	10.1	1630°F 888°C	1630°F 888°C	BNi 7
4775	74	14	4.5	4.5	3	—	1790°F 977°C	1900°F 1038°C	BNi 1
4777	82.6	7	3	4.5	2.9	—	1780°F 971°C	1830°F 999°C	BNi 2
4778	92.5	—	—	4.5	3	—	1800°F 982°C	1900°F 1038°C	BNi 3
4779	94.5	—	—	3.5	2	—	1800°F 982°C	1950°F 1066°C	BNi 4

Copper-Bearing

Fusion Number	Alloy Composition Cu	P	Ag	Zn	Other	Solidus Temp.	Liquidus Temp.	Specs. AWS A5.8
1190	75.0	7.25	17.75	—	—	1190°F 643°C	1191°F 644°C	—
1300	92.75	7.25	—	—	—	1310°F 710°C	1462°F 794°C	BCuP2
1306	86.75	7.25	6	—	—	1190°F 643°C	1325°F 718°C	BCuP4
1310	86.25	6.75	—	—	7 Sn	1184°F 640°C	1256°F 680°C	—
1320	91.75	8.25	—	—	—	1310°F 710°C	1320°F 716°C	—
1440	27	—	—	65.5	7.5Sn	1385°F 751°C	1440°F 782°C	—
1565	53	—	9	38	—	1450°F 788°C	1565°F 851°C	—
1600	54	—	4.5	41.5	—	1410°F 766°C	1635°F 890°C	—
1650	55	—	—	44.75	.25Mn	1610°F 877°C	1635°F 890°C	—
1660	58	—	—	39.60	1Sn .25Mn .1Fe .15Si	1590°F 866°C	1630°F 888°C	RBCuZn-C
1800	80	—	—	—	20Sn	1470°F 799°C	1635°F 890°C	—
1830	90	—	—	—	10Sn	1750°F 954°C	1830°F 999°C	—
1850	—	—	—	—	100Cu_2O	2040°F 1116°C	2100°F 1149°C	—
1900	100	—	—	—	—	1980°F 1082°C	1980°F 1082°C	BCu1a
1900-C	90	—	—	—	10Cu_2O	1980°F 1082°C	1980°F 1082°C	—
1900-F	95	—	—	—	5Fe_2O_3	1980°F 1082°C	1980°F 1082°C	—
1900-FC	90	—	—	—	7Cu_2O/3Fe_2O_3	1980°F 1082°C	1980°F 1082°C	—

Gold-Bearing

Fusion Number	Alloy Composition Au	Ag	Cu	Zn	Cd	Ni	Solidus Temp.	Liquidus Temp.	Specs. AWS A5.8
1742	82	—	—	—	—	18	1740°F 949°C	1740°F 949°C	BAu 4

Note: For information on karat gold alloys, request Bulletin A-106.

Fusion Aluminum Brazing Fluxes & Filler Metals

Fusion has several paste alloys for joining aluminum in open air, using conventional heating techniques and automated processes. Since the melting range of Fusion filler metals is very close to that of the base metals themselves, control of heat is most important. Both water washable and non-corrosive flux formulations permit joining of several commercially available aluminum base metals.

Non-Corrosive, KNC-1040-400 aluminum paste deposited to tube/core joints.

Water Washable

NDA Most potent fluxing action (contains halides) in this group. Affords the longest flux life for extended heating cycles. Flux residues are completely water washable. Pair with 1070, 1040, 1022, and A071 filler metals.

NPA Similar to NDA with milder, more controlled fluxing, which reduces base metal erosion and etching. Recommended for thin walled parts; water washable. Pair with 1070, 1040, 1022, and A071 filler metals.

NTA Similar to NDA with controlled fluxing and non-slumping characteristics. Creamy and smooth appearance due to fine mesh filler metals. Recommended for small diameter striping applications or any time paste must stay in place; water washable. Pair with 1070E, 1040E, 1022E, and A071E filler metals.

Non-Corrosive Fluxes

TNC Chloride-free flux that does not require post cleaning of the joint area. Flux residue has no detrimental effect on joint service life; not water washable. Pair with 1070, 1040, 1022, and A071 filler metals.

BNC Similar to TNC with higher temperature fluxing and reduced (visible) post brazing residue; not water washable. Pair with 1070 and 1040 filler metals.

KNC For use with lower melt point aluminum base metals like 6061 and 6262. Also suitable with 6063 and 3003 base metals; not water washable. Pair with 1040, 1022, and A071 filler metals.

GNC Similar to TNC; specially formulated to braze 5000 series aluminum and other magnesium-containing alloys. Also suitable for commonly used alloys; not water washable. Pair with 1070, 1040, 1022, and A071 filler metals.

Furnace Brazing Flux

FAB A non-corrosive formulation with reduced post-brazing residue. Pair with fine mesh 1070E, 1040E, 1022E, and A071E filler metals.

Melting Ranges for Popular Aluminum Base Metals

Base Metal	Melting	Range
1000 Series	1190 – 1215°F	643 – 657°C
3003	1190 – 1210°F	643 – 654°C
5005	1170 – 1210°F	632 – 654°C
6061	1080 – 1200°F	582 – 649°C
6063	1140 – 1210°F	616 – 654°C
6262	1078 – 1204°F	582 – 652°C
7072	1195 – 1215°F	646 – 657°C

Fusion Aluminum Brazing Filler Metals

Fusion Number	Nominal Alloy Composition Al	Si	Zn	Cu	Solidus Temp.		Liquidus Temp.		Specs.
1040	76	10	10	4	960°F	516°C	1040°F	560°C	Alum. Assn. 4245
1070	88	12	—	—	1070°F	577°C	1080°F	582°C	AWS BAlSi-4
1022	50	5	45	—	896°F	480°C	1022°F	550°C	—
A071	50	5	40	5	878°F	470°C	986°F	530°C	—

Fusion Aluminum Solder Fluxes & Filler Metals

Fusion has developed solder pastes which allow aluminum base metals to be joined at temperatures 300°F below their melting points. This is a significant advantage over conventional brazing filler metals, which typically permit a narrow 40°–100°F margin of safety. These pastes can be used in open air, using conventional heating techniques and automated processes.

Non-Corrosive Flux

ASN A non-corrosive solder flux recommended for applications such as aluminum heat exchangers, inlet/outlet tube assemblies, condenser "piccolo" joints, and other assemblies consisting of 6061 and 6262 base metals. The flux residue left after soldering is non-corrosive, thus no flux removal is required. Pair with all solder filler metals listed in the chart below.

Fusion Aluminum Solder Filler Metals

Fusion Number	Nominal Alloy Composition Zn	Al	Solidus Temp.		Liquidus Temp.		Specs.
738	98	2	720°F	378°C	738°F	388°C	—
A031	95	5	710°F	373°C	710°F	373°C	—
A131	88	12	718°F	380°C	815°F	435°C	—
845	85	15	718°F	380°C	845°F	452°C	—
892	80	20	756°F	402°C	892°F	478°C	—

Cleaning Brazed or Soldered Joints

Cleanliness of a brazed or soldered joint – both before and after assembly – is most important. Fusion offers Fuze-Clean metal preparation chemicals for precleaning and postcleaning of base metals. These products are supplied in a dry powder form and prepared by mixing with water at a specific ratio and temperature. Since these materials do not contain strong acids, they are generally safer than most conventional cleaning agents. Although conditions vary depending on the type of base and filler metals used, joint design, and performance requirements of the finished part, the following general guidelines may be helpful.

Precleaning (Surface Preparation)

Although a proper flux will remove and exclude light oxidation during heating, foreign matter such as grease, oil, paint, cutting fluids, etc. should be cleaned away before the part reaches the assembly point. If not removed, such materials may inhibit proper capillary attraction during heating and/or prevent the flux itself from acting directly on the metals being joined. Pre-cleaning methods may be divided into the following two categories:

Chemical Cleaning with solvents, acid or pickling baths compatible with the contaminants and the metals used. Such procedures should always be followed by thorough rinsing. Fusion offers the following pre-cleaner:

- **Fuze-Clean AB** An alkaline cleaner that removes heavy deposits of oil, grease, and soils from aluminum and brass surfaces.

Mechanical Removal of exceptionally heavy deposits via brushing, grinding or blasting with an abrasive agent. In the case of blasting, care must be taken that the abrasive itself is not left to contaminate the joint area. It is suggested that soldering or brazing be performed as soon as possible after any pre-cleaning operation.

Postcleaning (Flux Residues)

A significant benefit of the Fusion Paste Process is that the type and amount of flux is carefully controlled, yielding minimal flux residues. Nonetheless, flux residues of a corrosive nature must be removed to prevent damage to the joint over an extended period. Suggested cleaners for most popular Fusion fluxes are noted in the selector charts on pages 7 and 11. Since these, too, may vary depending on the base metal, heating techniques, etc., the following additional guidelines are offered:

Rosin Type Flux Residues Generally, these are non-corrosive and may be left on the part without damage to the joint area. If residue removal is desired, it may be removed using alcohols or chlorinated hydrocarbon solvents, or combinations of both families.

Activated Rosin Fluxes Some rosin activators will cause corrosion under unusually hot or humid conditions. Most may be removed using alcohols or chlorinated hydrocarbon solvents, or combinations of both families.

Oily or Greasy Flux Residues Generally may be removed with an alkaline cleaner such as Fuze-Clean S.

Intermediate and Corrosive Solder Fluxes (Halides) These fluxes leave a fused residue which absorbs airborne moisture, causing a slow chemical reaction at the joint. Removal is generally accomplished by thorough washing in warm detergent water, or in hot water containing dilute hydrochloric acid, followed by hot water rinse.

Aluminum Brazing Fluxes (Water Washable) Generally about 90% of such residues may be removed by immersing the hot part in water. For more thorough cleaning, immerse parts in a 15% nitric acid/85% water solution, under agitation for 30 seconds at room temperature, followed by two hot water (60-70°C) rinses at 20 seconds each, then a final cold water rinse.

Low-Temperature Brazing Fluxes These residues may be removed with hot water – along or with detergents, alkaline cleaners, or acid cleaners. The most effective method is largely dependent on the base metals involved.

High-Temperature Brazing Fluxes (Borates) These hard, glass-like deposits are insoluble in many cleaners. They may be cracked off, however, by quenching the hot assembly in water immediately after brazing. A solution of dilute hydrochloric acid may also be helpful. Fusion offers an all-purpose brazing postcleaner:

- **Fuze-Clean FS** Dissolves flux residues and heat scale on both ferrous and non-ferrous metals after brazing. It eliminates the use of strong acids and abrasive processes, besides removing rust, mill and heat scale directly on the production line. Use in an ultrasonic tank is recommended.

Glossary

As Applied to Fusion Paste Brazing & Soldering

Atmosphere A controlled brazing or soldering environment achieved by excluding oxygen and replacing it with one or a mixture of other gases. In production, this technique will minimize or eliminate the need for flux, as the atmosphere itself, combined with heat, acts to reduce existing surface oxides. Most often associated with furnace brazing.

Base Metal (Also, Parent Metal) The alloy or pure metal which is to be joined via soldering or brazing.

Binder A blending agent which, when added to paste brazing or soldering alloys, keeps the atomized filler metal and flux in stable suspension, prevents interaction of the two, and maintains extended shelf life.

Brazing A joining process whereby a non-ferrous filler metal is heated to melting temperature (above 840°F) and distributed between two or more close-fitting parts by capillary attraction. At its liquidus temperature, the molten filler metal interacts with a thin layer of the base metal, cooling to form an exceptionally strong joint due to grain structure interaction.

Capillary Attraction A natural force of adhesion governed by the relative attraction of liquid molecules for each other and for those of two adjoining solids. As applied to soldering or brazing, the process by which liquid flux and filler metal are transported along the length of a close-fitting joint.

Dew Point A reference method of determining the amount of water vapor (and resultant oxygen) in a controlled-atmosphere brazing operation. The Dew Point is that temperature at which water vapor of a given concentration will begin to condense, or become liquid.

Eutectic A specific alloy composition (two or more metals) that melts at a single temperature and not over a range: i.e., Solidus and Liquidus temperatures are the same.

Filler Metal An alloy or pure metal which, when heated, liquifies to flow into the space between two close-fitting parts, creating a brazed or soldered joint.

Fillet A clearly-defined bead of solder or brazing alloy which forms on and around the completed joint.

Fitup The joint clearance between two base metals to be soldered or brazed. Although requirements vary by technique and type of joint, optimum range for paste brazing and soldering is generally .002 to .004 inch.

Flux A material which, when heated, serves to remove and exclude surface oxides from the base metal. Brazing fluxes are generally of a highly corrosive nature. Solder fluxes may be classified into one of the following groups:

- **Non-corrosive** A rosin or mildly active organic acid used in wetting clean surfaces and producing a residue which is neither electrically conductive nor corrosive to the finished joint. Although such fluxes are active at elevated temperatures, they are inert at ambient temperature.
- **Intermediate** Generally, a mild organic acid which activates upon heating to achieve considerable stronger fluxing action than non-corrosive types. Relatively inert residue should be removed to ensure joint reliability.
- **Corrosive** Generally composed of strong organic or inorganic acids which promote high-speed cleaning of metals with strong surface oxides. Corrosive residue should be removed to prevent damage to the joint.

Liquidus The lowest temperature at which a particular metal or metal alloy will remain in a completely molten state. Generally considered the melting point of a particular filler metal.

Oxidation (Also, Surface Oxides) A chemical reaction promoted by oxygen and moisture in the air, wherein clean metal surfaces are covered with a metal oxide film which prevents proper wetting with soldering or brazing filler metal. Since oxidation accelerates during heating, the metal must not only be cleaned initially, but protected from oxidation during the joining process.

Slump The relative tendency of a paste alloy to sag or flow away from a sloping or vertical joint. Largely a function of paste rheology, this may occur while the assembly is cold, or during heating – before the paste alloy has reached melting temperature.

Soldering A joining process whereby a non-ferrous filler metal is heated to melting temperature (below 840°F and below that of the base metal) and distributed between two or more close-fitting parts by capillary attraction. Upon cooling, the filler metal adheres tightly to the base metal of either part, achieving coalescence.

Solidus The highest temperature at which a particular metal or metal alloy will remain completely solid.

Wettability (Also, Wetting Action) The ability of a specific flux and/or filler metal to flow onto a clean metal surface, unrestricted by oxidation or other impurities at the point of contact.