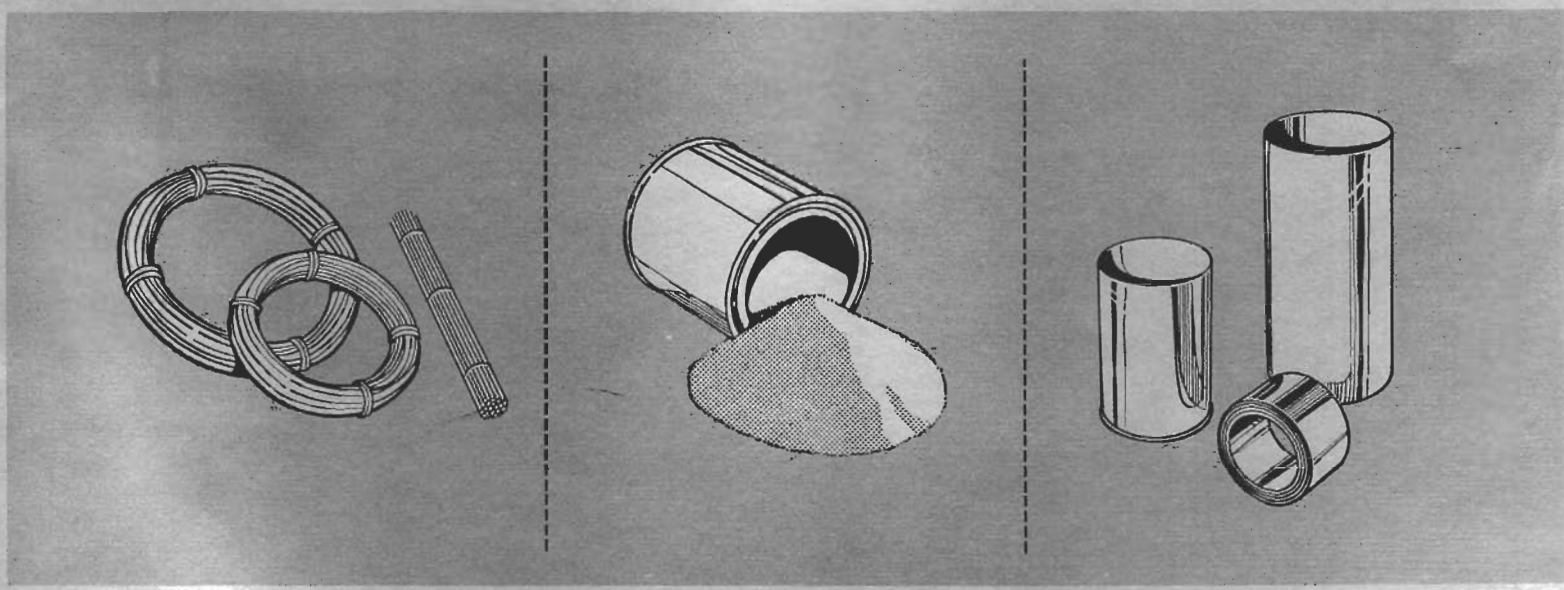
ENGELHARD

ENGELHARD INDUSTRIES DIVISION
ENGELHARD MINERALS & CHEMICALS CORPORATION
ROUTE #152, PLAINVILLE, MASSACHUSETTS 02762

SILVALOY

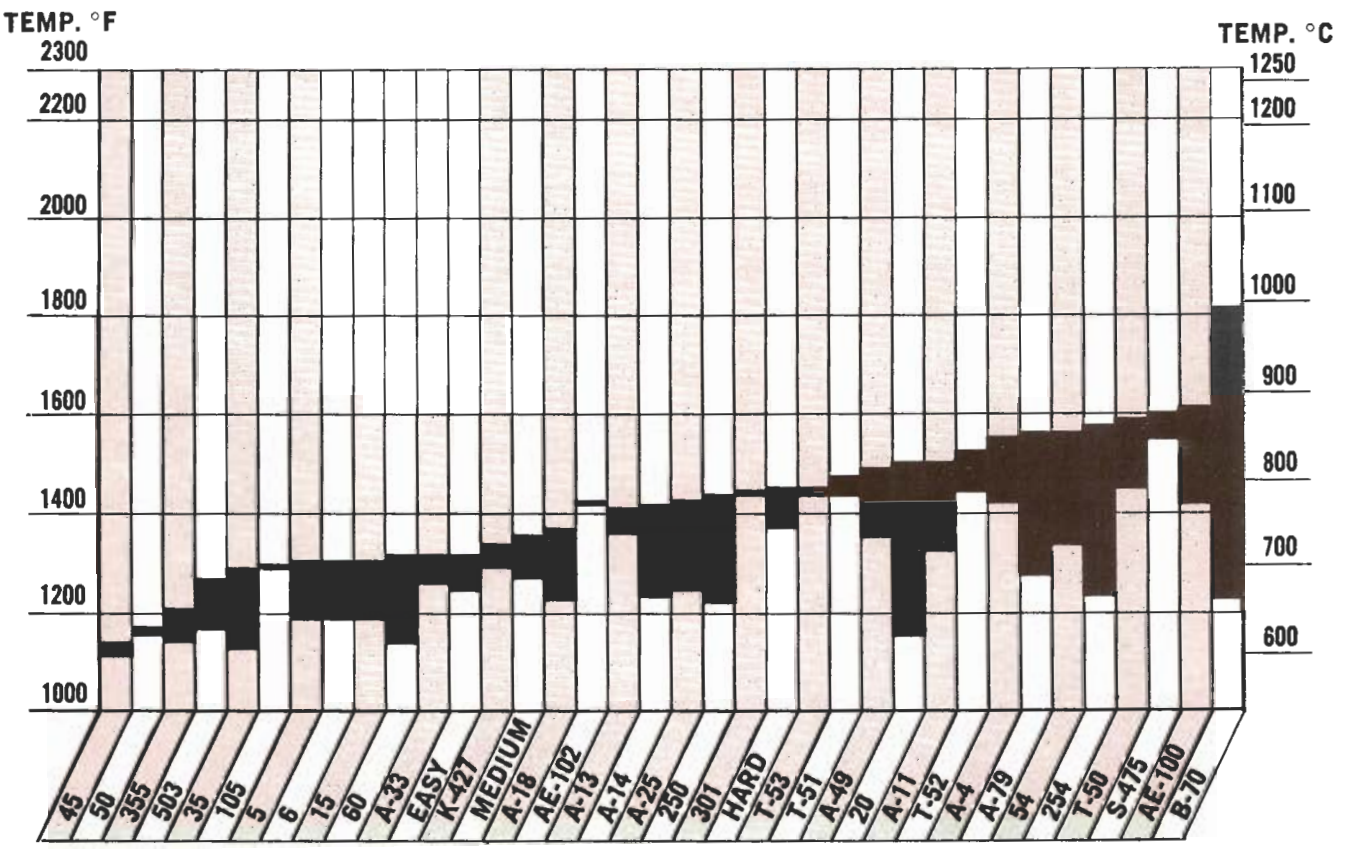


Brazing Alloys for Industry

ENGELHARD INDUSTRIES *one of the world's largest metal concerns, is particularly well equipped to manufacture Silvaloy brazing products. The facilities provide for refining, melting, fabricating all forms of precious metals as well as manufacture of rings, washers, and other preform brazing shapes. The supplementary brazing fluxes are also manufactured by Engelhard Industries Division. These production facilities are supplemented by test and control laboratories equipped with modern apparatus for control of silver and precious metal alloys.*

Engelhard sales representatives are available throughout the country to provide local service as required by the customer. When necessary, these local representatives will refer problems to the plant for further engineering assistance. Engelhard Industries is always available for consultation on brazing problems. Assistance is provided on brazing materials, their selection and specification design, production brazing procedures, testing, etc. Consult the offices on the back cover for service.

Solidus & Liquidus Brazing Filler Metals



SILVALOY®

Silvaloy No.	Nominal Compositions %					Solidus	Liquidus	Reference Page No.
	Ag	Cu	Zn	Cd	Other	°F	°F	
45	45	15	16	24		1125	1145	3
50	50	15.5	16.5	18		1160	1175	3
355	56	22	17		Sn-5	1145	1205	5
503	50	15.5	15.5	16	Ni-3	1170	1270	3
35	35	26	21	18		1125	1295	3
30	30	27	23	20		1125	1310	3
105	45	30	12		Mn-13	1298	1298	10
5	5	89			P-6	1190	1300	4
6	6	88			P-6	1190	1300	4
15	15	80			P-5	1190	1300	4
60	60	30			Sn-10	1115	1325	8
A-33	60	25	15			1245	1325	7
EASY	65	20	15			1240	1325	7
K-427	75		25			1300	1345	10
MEDIUM	70	20	10			1275	1360	7
A-18	45	30	25			1250	1370	6
AE-102	72	27.8			Li-.2	1410	1410	9
A-13	30	38	32			1370	1410	6
A-14	40	36	24			1235	1415	6
A-25	50	34	16			1270	1425	6
250	40	30	28		Ni-2	1240	1435	7
301	72	28				1435	1435	8
HARD	75	22	3			1365	1450	7
T-53	71.5	28			Ni-.5	1435	1450	9
T-51	75	24.5			Ni-.5	1435	1475	9
A-49	80	16	4			1345	1490	7
20	20	45	30	5		1140	1500	3
A-11	20	45	35			1315	1500	6
T-52	77	21			Ni-2	1435	1525	9
A-4	9	53	38			1410	1565	6
A-79	25	52.5	22.5			1250	1575	6
54	54	40	5		Ni-1	1325	1575	7
T-562	56	42			Ni-2	1420	1640	9
254	40	30	25		Ni-5	1220	1580	7
T-50	62.5	32.5			Ni-5	1435	1590	9
S-475	95				Al-5	1440	1510	10
AE-100	92.5	7.3			Li-.2	1435	1635	9
B-70	7	85			Sn-8	1225	1805	8

FLUX

ULTRA, 1100, BLACK, ALUMINUM BRONZE, DRY FLUX SUMMARY . . . P. 11

- ULTRA FLUX is a general purpose flux which gives best results on most brazing applications.
- 1100 FLUX is a low melting flux with a rapid cleaning action.
- BLACK FLUX is a premium flux which is similar to Ultra Flux except that it has an increased protective action.
- ALUMINUM-BRONZE FLUX is used to join aluminum-bronze by silver brazing.

Brazing Filler Metals

THE metal added to a joint during brazing is called a "Brazing Filler Metal". Brazing Filler Metals have often been referred to as Brazing Alloys, but the American Welding Society recognizes Brazing Filler Metals as the technically correct term to refer to metals used to produce a braze.

By definition, a braze is a weld produced by heating to a suitable temperature and distributing a filler metal by capillary flow between the surfaces of the joint. The filler metal must flow and complete the joint above 800°F, but below the melting temperature of the base metals. For good brazing results, there are other properties that may be desirable, such as:

1. Ability to wet and make a sound bond with the base metals on which it is to be used.
2. Suitable melting temperatures and flow properties which enable the alloy to be readily distributed by capillary attraction.
3. A composition that is:
   a. Sufficiently homogeneous to minimize separation of low melting and high melting components during the brazing process.
   b. Free of excessively volatile elements which might volatilize during a normal brazing cycle.
4. Mechanical, physical and chemical properties such as: strength, ductility, workability, corrosion resistance, oxidation resistance, electrical conduction, color, etc.

The A.W.S. — A.S.T.M. Specifications have divided brazing filler metals into the following classes according to composition and application:

1. Aluminum-Silicon
2. Copper-Phosphorus
3. Silver Alloy
4. Precious Metal
5. Copper and Copper-Zinc
6. Magnesium
7. Nickel Alloy

The silver alloy, copper phosphorus, and precious metal filler metals for industrial application are the products of Engelhard Industries which are reviewed here. The silver alloys are the most widely used, and the application procedures of these compositions are similar.

Silver alloys produce strong sound joints on steel, stainless steel, copper, brass, bronze, nickel, nickel alloys, precious metals, etc. In fact, they may be applied on all brazeable metals except aluminum and magnesium. All methods of heating may be used with the silver alloys such as torch, furnace, induction, salt bath, metal bath, etc. Because of this versatility, applications for silver brazing are found in all metalworking industries.

Industrial silver brazing has developed from the "Silver Soldering" process used by silversmiths for many years. The term "Silver Soldering" is still used by silversmiths to refer to brazing of silver articles. "Hard soldering" is another term which has also been used, but "brazing" is the modern term for the industrial process.

Silver, copper, and zinc were first used to make silver brazing alloys. Now other elements are also used to obtain desirable properties.

Cadmium or tin are used as additions to silver, copper, and zinc to produce a lower melting temperature. Cadmium, which is used more extensively, produces the lowest flow temperature at an economical composition, but tin has some advantages over cadmium because it is not toxic, less easily oxidized, produces a whiter alloy and is more active in promoting wetting of base metals.

Some other elements that are also used in silver brazing alloys are phosphorous to assist in reducing copper oxides, to promote flow and to lower the melting temperature; nickel to increase corrosion resistance and to assist in wetting stainless steels and tungsten carbide; and manganese to assist in wetting and to increase strength at elevated temperatures.

Melting of the Silver Brazing Alloys

Silver Brazing Filler Metals conform to specific chemical compositions which are guaranteed by the manufacturer. There are many industrial, federal and military specifications describing the commercially important compositions. These specifications are based on the chemical composition of the filler metal.

Most manufacturers also supply, as helpful information, temperature data on their alloys. Melting and flow points, remelt temperature, etc. have been used to describe melting of alloys, but the application of these terms has not always been consistent. For this reason solidus and liquidus, which are scientifically defined terms, are preferred. The solidus is defined as the highest temperature at which all of the alloy is completely solid and the liquidus is the lowest temperature at which all of the alloy is completely liquid.

Solidus and liquidus data on an alloy indicates the temperature during which the alloy transforms from a solid to a liquid. The range between the two temperatures is called the melting range of the alloy. In the melting range part of the alloy is liquid and part is solid. The alloy is in a semi-solid state which has been referred to as "plastic" or "mushy."

Some alloys have a long melting range during which the alloy is plastic (Silvaloy 503), while in other alloys the solidus and liquidus are close and the melting or plastic range is not perceptible during brazing. On certain compositions the solidus and liquidus occur at one temperature and the transformation from a solid to a liquid occurs without an intermediate state. This is called an eutectic composition. An example of this is Silvaloy 301.

When an alloy is heated to a temperature within its melting range a portion of the alloy will be liquid while the remaining portion is still solid. During a brazing operation, if the alloy is heated slowly through this range there may be time for the liquid portion to flow out leaving behind the higher melting portion. Thus, this higher melting portion being depleted of the dissolving action of the low melting constituent may not become fluid at the liquidus. This may leave the high melting portion of the alloy as a residue which does not contribute to the joint. Separation of the alloy in this manner has been called "Liquation." For best results alloys with long melting ranges should be heated rapidly through this range to complete melting before separation by liquation occurs.

The melting range is an indication of the behavior of the alloy, but the amount of separation which occurs with any alloy will also be influenced by the percentage of the alloy which becomes fluid early in the melting stage and by the fluidity of the molten portion.

Generally, a short melting range is desirable for a brazing filler metal although there are occasions where, as an expediency, it may be desirable to have an alloy with a melting range in which it becomes plastic or mushy and can be applied in this mushy state to build large fillets or to fill gaps.

Proper Brazing Temperatures

During brazing the joint area of the work and brazing filler metal must be heated to the brazing temperature. Since the brazing filler metal is distributed throughout the joint by capillary flow the area where this flow is to occur must be properly heated to permit the filler metal to wet and alloys with the work surfaces. In practice, to assure that all sections of the joint reach a suitable temperature, the work is commonly heated 50°F or more above the minimum brazing temperature of the brazing alloy.

For proper capillary brazing, the alloy should flow freely into the joint. It is obvious that the alloy should be fluid for proper flow. For most filler metal compositions complete flow of the alloy is obtained at the liquidus, however, a few brazing alloys become essentially 100% molten and flow freely even though the liquidus is not reached and a few minute solid crystals remain. When these crystals do not restrict the capillary flow of the alloy brazing may be done below the liquidus.

Silvaloy 15 and Silvaloy 5 are examples of compositions where satisfactory flow is obtained below the liquidus. These alloys are fluid at 1300°F, but have true liquidus of 1500°F. In this case, tests have shown the best temperature for brazing to be slightly above 1300°F.

Solidification of the Brazing Filler Metal

After completing the joint, the assembly must be secured until the last portion of the alloy has solidified. Any relative motion of the members of the joint while the alloy is in the melting range may result in weakened or broken joints.

With an alloy which apparently becomes solid before passing through the solidus (Silvaloy 20 is apparently solid at about 1400°F, but its solidus is 1140°F), avoid moving the assembly until it has cooled below the solidus. Stress should not be placed on the joint until it has cooled well below the solidus and developed physical strength.

Ag-Cu-Zn-Cd
Brazing Filler Metals

Description

These silver-copper-zinc-cadmium alloys are low melting alloys suitable for brazing steel, stainless steel, copper, copper alloys, nickel, nickel alloys, or combinations of these metals.

SILVALOY 50 is a low-melting alloy which flows freely when molten. It has a short melting range (1160-1175°F) which is not apparent in most brazing operations.

SILVALOY 45 is an alloy developed as a low temperature free-flowing alloy which is more economical than SILVALOY 50 because of its 5% lower silver content. This alloy has wide acceptance by industrial users. SILVALOY 45 is also included in the federal and military specifications.

The short melting range (1125-1145°F) of SILVALOY 45 is not apparent in most brazing operations.

SILVALOY 30 and SILVALOY 35 have a silver content lower than SILVALOY 45 or SILVALOY 50. When comparing SILVALOY 45 or SILVALOY 50 with SILVALOY 30 and SILVALOY 35, consideration must be given to the (120-165°F) increase in brazing temperatures, and to possible liquidation in its melting range.

SIVALOY 20 is a 20% silver alloy with a flow temperature of 1500°F. It has good flow properties and is used where the color match with brass is important.

CHEMICAL COMPOSITION

SILVALOY	Ag %	Cu %	Zn %	Cd %	Total Other Elements % Max.
50	50±1	15.5±1	16.5±2	18±1	.15
45	45±1	15 ±1	16 ±2	24±1	.15
35	35±1	26 ±1	21 ±2	18±1	.15
30	30±1	27 ±1	23 ±2	20±1	.15
20	20±1	45 ±1	30 ±2	5±1	.15

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1160	1175	**50**	627	643
1125	1145	**45**	606	618
1125	1295	**35**	606	701
1125	1310	**30**	607	710
1140	1500	**20**	616	816

STANDARD FORMS

These alloys are made in sheet, strip, wire, powder, and special preformed shapes.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity	Electrical Conductivity
50	5.00	9.49	24.8%
45	4.92	9.34	27.6%
35	4.90	9.29	27.5%
30	4.61	8.76	26.5%
20	4.64	8.80	24.4%
			Cu-100%

Silvaloy 503
Ag-Cu-Zn-Cd-Ni
Brazing Filler Metal

Description

SILVALOY 503 has a melting range and is suitable for steel, stainless steel, copper, copper alloys, nickel, nickel alloys, or combinations of them. It is used for brazing tungsten carbide tool tips.

SILVALOY 503 was originally introduced because of somewhat better corrosion resistance than the SILVALOY 50 for certain conditions, and is still used for such purposes. It has proven successful on many marine applications and for stainless steel equipment which must withstand strong cleaning solutions. The 3% nickel content of this alloy also improves its wetting of stainless steel and tungsten carbide tool tips. At the present time, largest use of this filler metal is for attaching carbide cutting tips to tool shanks.

When melting, SILVALOY 503 passes from the solid state to a mushy or plastic range and progressively to a liquid. The largest portion of SILVALOY 503 melts in the upper section of its temperature range. Therefore, the alloy has a good body while in the plastic range and is suitable for building fillets or bridging large gaps. Late melting of the major portion of the alloy also helps to minimize any separation of the solid and liquid portions by liquation during melting.

Low carbon steel, carbon steel, stainless steel, alloy steel, manganese steel, copper, red brass, yellow brass, tungsten carbide and combinations of these metals, may be joined with SILVALOY 503.

CHEMICAL COMPOSITION

SILVALOY	Ag %	Cu %	Zn %	Cd %	Ni %	Total Other Elements % Max.
503	50±1	15.5±1	15.5±2	16±1	3±.5	.15

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1170	1270	**503**	632	688

STANDARD FORMS

SILVALOY 503 is available in sheet, wire, strip, powder, and special preform shapes.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity	Electrical Conductivity
503	5.00	9.49	18.0% Cu - 100%

Ag-Cu-P
Brazing Filler Metal

Description

The phosphorus content of these compositions acts as a fluxing agent on copper and often the usual paste flux may be omitted. However, flux will facilitate brazing, minimize defects and improve the joint quality. Use of flux is recommended on large parts. Paste flux is required on copper alloys such as brass and bronze. Phosphorus alloys of this type are not used on ferrous or nickel alloys because of the brittle joints that are formed by the reaction of phosphorus and iron or nickel.

Copper tubing or electrical connections are brazed extensively with copper-silver-phosphorus alloys. Brazing without a flux is a real advantage in many of these operations such as closed tubing systems and on stranded or laminated conductors where flux removal after brazing is impossible.

These compositions melt from the solid state to a mush or plastic stage and progressively to a liquid. To avoid difficulties caused by liquation of the alloy, the work should be heated rapidly through its melting range. On work being torch brazed, manual feeding is usually used. The work should be heated until the flow temperature is reached (1300°F) before applying the alloy. Then the alloy is laid along the joint boundary with care that the flame is not directed at the filler metal but heats the joint generally. Brazing with these alloys is a straight forward procedure. Because of the gradual melting of the alloy, less skill in judging temperatures may be required of the manual brazer.

SILVALOY 15 has more ductility than the lower silver alloys, lower brazing temperature, and greater ease of application. It is intended primarily for use on copper, and copper alloys, but may also be used on silver, tungsten, and molybdenum.

SILVALOY 5 and SILVALOY 6 have come into use as a lower cost replacement for SILVALOY 15.

Their composition has been adjusted to provide brazing properties close to SILVALOY 15. The melting temperature, flow temperature, and the progression of alloy from a solid to a liquid, are similar to that of SILVALOY 15.

CHEMICAL COMPOSITION

SILVALOY	Ag %	P %	Cu %	Total Other Elements % Max.
5	5.0±.25	6.00±.25	89.0±1	.15
6	6.0±.25	6.0 ±.25	88.0±1	.15
15	15.0±.5	5.0 ±.25	80.0±1	.15

MELTING RANGE

	SILVALOY 5		SILVALOY 6		SILVALOY 15	
	°F	°C	°F	°C	°F	°C
Solidus (melting point)	1190	643	1190	643	1190	643
Flow Temp.	1300	704	1300	704	1300	704
Liquidus	1500	816	1460	793	1500	816

NOTE — Melting of these alloys are virtually complete at 1300°F and best brazing results are usually obtained when temperatures slightly above 1300°F are reached. However, the true liquidus occurs at the temperatures indicated.

STANDARD FORMS

SILVALOY 5 and 6 are made in extruded rod and wire, and also preform rings. SILVALOY 15 is made in extruded rod, wire, sheet, strip, powder, and special preformed shapes.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity	Electrical Conductivity
5	4.37	8.29	9.8%
6	4.37	8.29	9.8%
15	4.45	8.45	14.0%
			Cu - 100%

Silvaloy 355
Ag-Cu-Zn-Sn
Brazing Filler Metal

Description

SILVALOY 355 is a low melting alloy suitable for use on steel, stainless steel, copper, copper alloys, nickel, nickel alloys, or combinations of them.

SILVALOY 355 is a low melting, free flowing alloy with a slight plastic range which may be noticed during melting on some application.

Steel, stainless steel, nickel, and nickel alloy, copper, copper alloys, and combinations of them may be joined with SILVALOY 355.

The whitish color of SILVALOY 355 has led to applications on white-colored metals where color match is important. Stainless steel and sterling silver are two such metals. The amount of brazing alloy exposed and the finishing of the surfaces will influence this color matching. If the exposed surface of the alloy is kept to a minimum and is polished after brazing, the joint may be made invisible.

The fact that SILVALOY 355 contains no cadmium has led to its use on food handling equipment where cadmium may be a hazard and its use is prohibited by law. SILVALOY 355 has a lower volatile metal content. For this reason, it is often preferred over SILVALOY 35, SILVALOY 45, or SILVALOY 50 for furnace brazing, or any brazing operation where the alloy is molten for an extended period of time.

SILVALOY 355 has been found helpful on applications of brazing stainless steel, nickel or nickel alloys where stress cracking occurs during brazing. Many applications can be brazed successfully with SILVALOY 355 without stress cracking which are not possible with other low melting alloys.

CHEMICAL COMPOSITION

SILVALOY	Ag %	Cu %	Zn %	Sn %	Total Other Elements % Max.
355	56±1	22±1	17±2	5±.5	.15

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1145	1205	**355**	619	652

STANDARD FORMS

SILVALOY 355 is available in sheet, wire, strip, powder, and special preform shapes.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity	Electrical Conductivity
355	5.00	9.49	11.9%
			Cu - 100%

Description

These silver-copper-zinc alloys are general purpose brazing compositions usually used on steel, stainless steel, copper, copper alloys, nickel, nickel alloys, and combination of these metals. The different compositions provide a range in brazing temperatures. The color of the alloys vary from brass (yellow) in the lowest silver (SILVALOY A-4) to white in the highest silver (SILVALOY A-25) content.

SILVALOY A-4 — Brass-like appearance has lead to use where color match with brass is important (band instruments) also good for use on steel at 1565°F.

SILVALOY A-11 — Similar to A-4 except lower temperature.
SILVALOY A-79 — Has been widely used for furnace brazing (flux required).
SILVALOY A-13 — Has narrow melting range and good flow.
SILVALOY A-14 — For general purpose brazing.
SILVALOY A-18 — For general purpose brazing.
SILVALOY A-25 — Used by electrical manufacturers for general purpose brazing in the upper temperature range for silver brazing.

CHEMICAL COMPOSITION

SILVALOY	Ag %	Cu %	Zn %	Total Other Elements % Max.
A-4	9±1	53 ±1	38 ±2	.15
A-11	20±1	45 ±1	35 ±2	.15
A-79	25±1	52.5±1	22.5±2	.15
A-13	30±1	38 ±1	32 ±2	.15
A-14	40±1	36 ±1	24 ±2	.15
A-18	45±1	30 ±1	25 ±2	.15
A-25	50±1	34 ±1	16 ±2	.15

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1410	1565	A-4	765	838
1315	1500	A-11	710	815
1250	1575	A-79	677	855
1370	1410	A-13	743	766
1235	1410	A-14	668	768
1250	1370	A-18	677	743
1270	1425	A-25	688	773

STANDARD FORMS

These alloys are made in sheet, strip, wire, powder, and special preformed shapes.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity	Electrical Conductivity
A-4	4.50	8.54	20.5%
A-11	4.68	8.88	24.4
A-79	4.71	8.94	24.4
A-13	4.67	8.86	24.4
A-14	4.80	9.11	19.7
A-18	4.82	9.15	19.0
A-25	4.99	9.47	22.0
			Cu - 100%

Silversmith Alloys

Description

Silversmith Alloys are used primarily for joining of sterling silver. Their composition is selected to provide: (1) A close color match with sterling silver (2) A series of flow temperatures in several steps to permit step brazing (step brazing is brazing a sequence of joints on one assembly using a lower brazing temperature for each step to avoid remelting already completed joints) (3) Suitable flow for good filling of fitted joints. Silversmith Alloys have relatively low zinc content and are suitable for longer heating cycles i. e. furnace brazing. They have good ductility and are sometimes used to join copper and copper alloys which will be drawn or worked after brazing. For joining sterling select compositions for lowest brazing temperature to minimize the brazing temperature required.

The wetting action of these alloys is relatively poor on ferrous metals and their primary use is on silver and silver alloys with some applications on copper and copper alloys.

CHEMICAL COMPOSITION

SILVALOY	Ag %	Cu %	Zn %	Total Other Elements % Max.
A-33	60±1	25±1	15±2	.15
Easy	65±1	20±1	15±2	.15
Medium	70±1	20±1	10±2	.15
Hard	75±1	22±1	3±1	.15
A-49	80±1	16±1	4±1	.15

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1245	1325	A-33	674	718
1240	1325	Easy	671	718
1275	1360	Medium	690	738
1365	1450	Hard	740	788
1345	1490	A-49	729	810

STANDARD FORMS

These alloys are made in sheet, strip, wire, powder, and special preformed shapes.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity	Electrical Conductivity
A-33	5.02	9.52	20.5%
Easy	5.06	9.60	21.3%
Medium	5.14	9.75	26.7%
Hard	5.28	10.02	53.4%
A-49	5.29	10.05	45.8%
			Cu - 100%

Brazing Filler Metals

Description

These alloys are used for brazing steel, stainless steel, copper alloys, nickel, nickel alloys, and combinations of these metals. The nickel content promotes wetting of difficult to wet metals such as stainless steels, tungsten, carbide, etc. It also improves resistance to corrosion.

SILVALOY 250 is a good general purpose brazing alloy for brazing temperatures above 1435°F. It is used for brazing tungsten carbide tool blanks where it has a lower silver content than SILVALOY 503 and on some applications, its higher brazing temperature (compared with SILVALOY 503) is desired to promote better service where somewhat elevated service temperatures may be encountered.

SILVALOY 254 contains 5% nickel and is used primarily for brazing of tungsten carbide inserts in mining drills. These drills are usually heat-treated during the brazing cycle. SILVALOY 254 does not flow as extensively as No. 503 or No. 250 and is retained in the joint better during the extended heat treating cycle.

SILVALOY 54 is used extensively for silver brazing of aircraft and missile assemblies. It has good wetting on stainless steel nickel alloys and other high strength metals used in this industry. The description in Aeronautical Material Specification 4772 suggests this composition for use on aircraft applications for service up to 800°F.

CHEMICAL COMPOSITION

SILVALOY	Ag %	Cu %	Zn %	Ni %	Total Other Elements % Max.
250	40±1	30±1	28±2	2±.5	.15
254	40±1	30±1	25±2	5±.5	.15
54	54±1	40±1	5±1	1±.5	.15

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1240	1435	250	671	780
1220	1580	254	660	860
1325	1575	54	718	855

STANDARD FORMS

These alloys are made in sheet, wire, strip, powder, and special preform shapes.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity	Electrical Conductivity
250	4.76	9.04	16.8%
254	4.72	8.95	14.5%
54	5.06	9.61	48.5%
			Cu - 100%

Ag-Cu-Sn
Brazing Filler Metals

Description

Silver-copper-tin compositions are used for joining ferrous metals, copper, copper alloys, nickel, nickel alloys, and combinations of these metals. The tin content provides good wetting on many difficult to wet metals such as stainless steel and tungsten carbide. These alloys, being free of Zn or Cd are preferred for long heating cycles and are suitable for use in controlled atmosphere brazing without flux. The largest use of these alloys is for furnace brazing although they are also suitable for other brazing procedures.

CHEMICAL COMPOSITION

SILVALOY	Ag %	Cu %	Sn %	Total Other Elements % Max.
60	60±1	30±1	10±1	.15
B-70	7±1	85±1	8±.5	.15

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1115	1325	60	600	718
1225	1805	B-70	663	983

STANDARD FORMS

These alloys are made in sheet, strip, wire, powder, and special preformed shapes.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity	Electrical Conductivity
60	5.23	9.92	9.8%
B-70	5.42	10.28	13.8%
			Cu-100%

Ag-Cu
Brazing Filler Metals

Description

Silver-copper alloys are primarily used for brazing in a suitable controlled atmosphere to eliminate the need for flux. The wetting action on ferrous metals is slow, minimizing their use on carbon steel but furnace brazing of stainless steel with silver-copper filler metals is suitable for commercial applications. Most applications for these alloys are on copper and nickel base metals.

The silver-copper alloys are available in vacuum tube grade as well as the commercial grade described here. The composition of both grades is the same except that there is greater control of the trace impurities in the vacuum tube grade.

SILVALOY 301 is the eutectic composition of the silver-copper system (transforming sharply from a solid to a liquid at the same temperature) and is extremely fluid when molten.

CHEMICAL COMPOSITION

SILVALOY	Ag %	Cu %	Total Other Elements % Max.
301	72±1	28±1	.15

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1435	1435	301	778	778

STANDARD FORMS

These alloys are made in sheet, strip, wire, powder, and special preformed shapes.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity	Electrical Conductivity
301	5.24	9.95	77.1%
			Cu - 100%

Ag-Cu-Ni
Brazing Filler Metal

Description

Silver-copper-nickel brazing alloys are recommended for atmosphere furnace brazing or other applications where the use of volatile elements must be avoided. The different compositions offer variation in nickel content, brazing temperature, and flow during the brazing operation.

The nickel constituent improves the wetting action of the molten brazing alloy on steels, stainless steel and many corrosion resistant base metals. Nickel also promotes better filleting of the molten alloy, therefore, the flow of these alloys is easier to control and usually is restricted to the joint area.

CHEMICAL COMPOSITION

SILVALOY	AG %	Cu %	Ni %
T-50	62.5±0.5	Bal.	5.0±0.5
T-51	75.0±1.0	Bal.	0.5±0.25
T-52	77.0±1.0	Bal.	2.0±0.5
T-53	71.5±0.5	Bal.	0.5±0.2
T-562	56 ±1.0	Bal.	2.0±0.5

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1435	1590	T-50	778	866
1435	1475	T-51	778	802
1435	1525	T-52	778	830
1435	1450	T-53	788	788
1420	1640	T-562	771	893

STANDARD FORMS

These alloys are available in wire, sheet, strip and preforms.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity	Electrical Conductivity
T-50	5.19	9.84	54.2%
T-51	5.30	10.05	75.5%
T-52	5.32	10.09	76.5%
T-53	5.27	9.99	64.5%
T-562	5.14	9.75	52.0%
			Cu-100%

Ag-Cu-Li
Brazing Filler Metals

Description

SILVALOY AE-100 — SILVALOY AE-100 is a silver brazing filler metal for use in a controlled atmosphere brazing process. When molten, SILVALOY AE-100 flows freely, forming small fillets. The alloy contains 0.2% lithium to promote flow and wetting during atmosphere brazing of precipitation hardening stainless steels. Atmospheres used for brazing must be of sufficient purity and dryness to provide a bright surface on the base metal at the temperatures used in the operation. The largest application for SILVALOY AE-100 is brazed honeycomb assemblies.

SILVALOY AE-102 — SILVALOY AE-102 is a silver brazing filler metal for use in a controlled atmosphere brazing process. When molten, SILVALOY AE-102 flows freely, forming small fillets. The alloy contains 0.2% lithium to promote flow and wetting on stainless steel surfaces. Atmospheres used for brazing must be of sufficient purity and dryness to provide a bright surface on the base metal at the temperatures used in operation.

CHEMICAL COMPOSITION

SILVALOY	Ag %	Li %	Cu %	Total Other Elements % Max.
AE-100	92.5±.5	0.2 +0.1 −0.05	Bal.	.15
AE-102	72.0±1.0	0.2 +0.1 −0.05	Bal.	.15

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1435	1635	AE-100	780	890
1410	1410	AE-102	765	765

STANDARD FORMS

SILVALOY AE-100 is available in wire, strip, and sheet for honeycomb brazing up to 12" widths.

SILVALOY AE-102 is available in sheet, wire, and strip.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity
AE-100	5.46	10.36
AE-102	5.22	9.90

Ag-Zn
Brazing Filler Metals

Description

SILVALOY K-427 is a special purpose alloy generally used where a copper free composition is desired.

CHEMICAL COMPOSITION

SILVALOY	Ag %	Zn %	Total Other Elements % Max.
K-427	75±1	25±1	.15

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1300	1345	K-427	704	730

STANDARD FORMS

This filler metal is available in wire, sheet, powder, and preforms.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity
K-427	5.06	9.6

Ag-Cu-Zn-Mn
Brazing Filler Metals

Description

SILVALOY 105 is a low melting alloy with a manganese content which increases strength at elevated service temperatures. The good wetting action of Silvaloy 105 has led to application on difficult to wet carbides.

CHEMICAL COMPOSITION

SILVALOY	Ag %	Cu %	Zn %	Mn %	Total Other Elements % Max.
105	45±1	30±1	12±2	13±1	.15

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1298	1298	105	703	703

STANDARD FORMS

This filler metal is available in wire, sheet, powder, and preforms.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity
105	4.76	9.0

Ag-Al
Brazing Filler Metals

Description

SILVALOY S-475 is used for brazing titanium and columbium. It has good corrosion resistance, has high strength, forms fillets well, has low erosion characteristics.

CHEMICAL COMPOSITION

SILVALOY	Ag %	Al %	Total Other Elements % Max.
S-475	95±1	5±1	.15

MELTING RANGE

Solidus °F	Liquidus °F	SILVALOY	Solidus °C	Liquidus °C
1440	1510	S-475	843	871

STANDARD FORMS

This filler metal is available in wire, sheet, powder, and preforms.

PROPERTIES

SILVALOY	Density tr. ozs./cu. in.	Specific Gravity
S-475	5.73	10.86

Summary of Silver Products Brazing Fluxes

ULTRA FLUX is a general purpose flux which gives best results on most brazing applications. It is satisfactory on all metals joined by silver brazing except on alloys with an appreciable aluminum content, or on Titanium. Ultra Flux may be applied with all heating methods. Its effective range is 1100 to 1600°F. Ultra Flux is readily diluted to a thin consistency with water or heating 150 to 175°F. It can be applied by brush, dip or spray. Ultra Flux has good wetting and the braze joint quality is excellent. Flux residue is easily removed with warm water. Ultra Flux retains its non-gritty creamy consistency for long storage periods.

1100 FLUX is a low melting flux with a rapid cleaning action. It is most satisfactory on small parts which are heated quickly and on which the brazing is completed within a short heating time. 1100 Flux will withstand very fast heating and clean the work faster than other fluxes, particularly when torch brazing. 1100 Flux spends itself rapidly on ferrous metals. It is usually used for brazing of copper, and copper alloys.

BLACK FLUX is a premium flux which is similar to Ultra Flux except that it has an increased protective action. This provides a real advantage on operations where longer heating cycles are encountered or where higher melting alloys are used. It is ideal for induction, furnace, and torch heating; where longer heating cycles or higher temperatures are encountered. Black Flux may be applied on all metals joined by silver brazing but has particular advantage on metals which form persistent oxides such as stainless steel or other alloys containing chromium or manganese.

ALUMINUM-BRONZE FLUX is used to join aluminum-bronze by silver brazing. A special flux is required for this work because the other fluxes are not effective in fluxing the aluminum content of this metal. Aluminum-Bronze Flux is also useful for joining K-Monel.

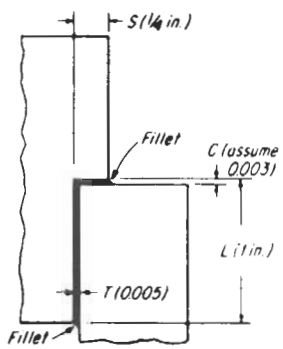
Estimating wire diameter of brazing ring preforms

Volume of the preform must be sufficient to fill the joint gap or shear area, the shoulder plus the fillets. Calculations are simplified by determining cross-section area of the braze metal rather than volume. Because the preform ring has approximately the same pitch diameter, the wire diameter with an equivalent area will correspond in volume to the joint. In the typical joint, area is found in shear area and the shoulder, and allowance is added for the fillets and the wire diameter selected by its cross-sectional area.

= L X T + S X C + fillet allowance (10% for large joints and varies up to 50% for small joints)

= 0.0068 sq. in.

Wire diameter to use is 3/32 in., from table below.



WIRE DIAMETER					
B & S Gage or Fraction of Inch	Decimal	Cross Section Area of Wire	B & S Gage or Fraction of Inch	Decimal	Cross Section Area of Wire
1/8"	.125"	.0123 sq. in.	17	.0453"	.00161
9	.114"	.0103	18	.0403"	.00128
10	.102"	.00816	19	.0359"	.00101
3/32"	.0937"	.00689	20	.0320"	.00080
11	.0907"	.00647	1/32"	.0312"	.00077
12	.0808"	.00513		.0300"	.00071
	.0750"	.00442	21	.0285"	.00064
13	.0720"	.00407	22	.0254"	.00051
	.0700"	.00385	23	.0226"	.00040
14	.0641"	.00323	24	.0201"	.00032
1/16"	.0625"	.00306	25	.0179"	.00025
	.0600"	.00283	26	.0159"	.00020
15	.0571"	.00256	1/64"	.0156"	.00019
	.0550"	.00237	27	.0142"	.00016
16	.0508"	.00203	28	.0126"	.00013
	.0500"	.00196	29	.0113"	.00010
3/64"	.0468"	.00173	30	.0100"	.000079

Approximate amount of brazing filler metal per troy ounce

WIRE FORMS		
Approximate Inches Per Unit Weight		
Wire Diameter	Silvaloy 50	Silvaloy 15 & 5
.015"	1130 in./tr. oz.	
.025"	407	
.031"	260	4272 in/lb.
.040"	159	2610
.047"	116	1900
.062"	65	1068
.093"	29	475
.125"	16	267
.156"		170
.250"		67

SHEET FORMS		
Approximate Square Inches Per Unit Weight		
Sheet Thickness	Silvaloy 50	Silvaloy 15
.003"	66 sq. in/tr. oz.	1066 sq. in/lb.
.004"	50	792
.005"	40	656
.007"	28	467
.010"	20	328
.020"	10	164
.025"	8	132
.030"	7	109