Johnson Matthey

SIL-FOS™
COPPER-FLO™

SILVER/COPPER-PHOSPHORUS BRAZING FILLER METALS

SIL-FOS™ & COPPER-FLO™

BRAZING FILLER METALS

contents

products at a glance

Compositions

These products have the following compositions:	Sil-fos™	Ag Cu P
	Copper-flo™	Cu P Sn Sb

Standard products are supplied to conform to ISO17672.
Special products conform to proprietary Johnson Matthey specifications.

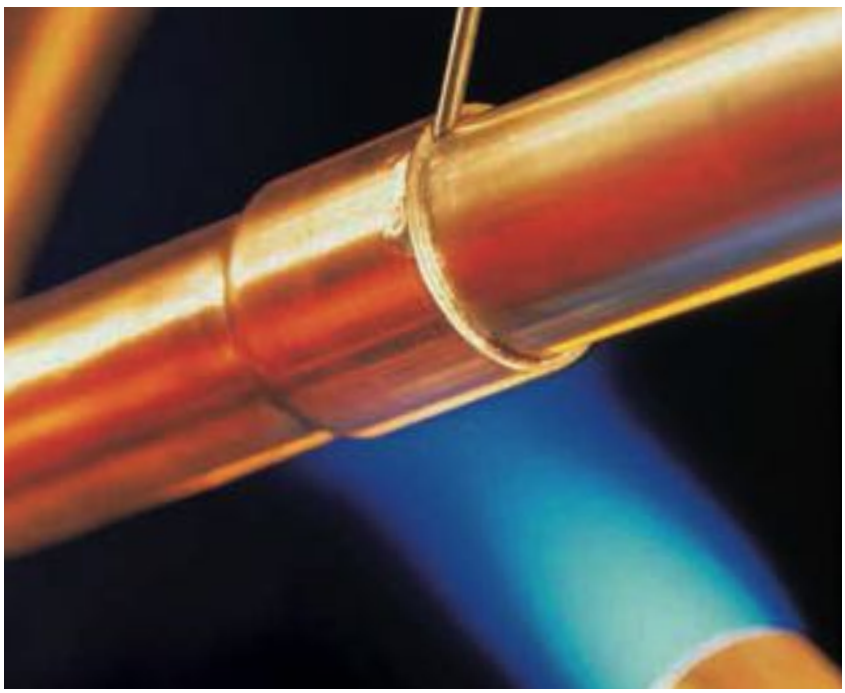
Uses for the Products

The Sil-fos™ and Copper-flo™ products are most commonly used to form joints on the following materials:

- Copper tubes, pipes and fittings
- Copper alloys including brass, bronze, nickel silver and aluminium-bronze
- Electrical engineering applications

Conditions for Use

The Sil-fos™ and Copper-flo™ products are typically used for brazing in air using a hand torch, fixed burner system, high frequency induction or resistance heating.
These products are self-fluxing when used on copper. When used to braze copper alloys a compatible brazing flux should be used. This can be applied using a Johnson Matthey flux powder or paste, or a brazing paste with a flux binder system included.



SIL-FOS™ & COPPER-FLO™

products

silver/copper-phosphorus brazing filler metals

these products are mainly used for brazing copper to copper. they are self-fluxing on copper and therefore do not require a separate flux for this application.

Sil-fos ™Plus

Ag	Cu	P
18	75	7
Melting Range		644˚C
EN1044: 1999		CP101
ISO 17672:2010		CuP 286

Sil-fos™ Plus is the most free flowing filler metal from the Sil-fos™ range. It is used in niche applications where its low melting temperature, flow properties and electrical conductivity are an advantage. Sil-fos™ Plus is not particularly ductile and should not be used in applications where vibration, stress or deformation of the joint in service are possible.

Properties	Product Forms
-50 / 150˚C	
1 Flow	
Low 1	
0.025-0.075 mm	
650˚C	

Sil-fos ™

Ag	Cu	P
15	80	5
Melting Range		644-800˚C
EN1044: 1999		CP102
ISO 17672:2010		CuP 284

Sil-fos™ is a widely used product being the most ductile of the silver/copper-phosphorus brazing filler metals and the only one available as a foil. It is used extensively in electrical engineering applications where it is used to make electrically conductive joints. It is also used in heating and ventilation and refrigeration applications to join copper pipes.

Properties	Product Forms
-50 / 150˚C	
2 Flow	
High	
0.05-0.2 mm	
700˚C	

Sil-fos ™6

Ag	Cu	P
6	86.75	7.25
Melting Range		644-718˚C
EN1044: 1999		-
ISO 17672:2010		CuP 283

Sil-fos™ 6 is one of the most free flowing filler metals from the Sil-fos™ range making it popular in heat exchanger, air conditioning and refrigeration (HVAC&R) applications. It is also one of the least ductile and should not be used in applications involving exposure to strong vibrations, impact loads or where some deformation of the joint might be expected in service.

Properties	Product Forms
-50 / 150˚C	
1 Flow	
Low[1]	
0.025-0.075 mm	
720˚C	

Sil-fos ™5

Ag	Cu	P
5	89	6
Melting Range		644-815˚C
EN1044: 1999		CP104
ISO 17672:2010		CuP 281

Sil-fos™ 5 provides the best combination of flow and ductility of all the silver/copper-phosphorus type brazing filler metals. As a result it is extensively used in heat exchanger, air conditioning and refrigeration (HVAC&R) applications for flux-free brazing of copper pipes and tubes. It is also used for joining copper and copper alloys in electrical engineering applications.

Properties	Product Forms
-50 / 150˚C	
2 Flow	
Medium	
0.05 - 0.2 mm	
710˚C	

Silbralloy ™

Ag	Cu	P
2	91.7	6.3
Melting Range		644-825˚C
EN1044: 1999		CP105
ISO 17672:2010		CuP 279

Silbralloy™ sits between Sil-fos™ 5 and Copper-flo™. It is less ductile and free flowing than Sil-fos™ 5 but more ductile whilst being less free flowing than Copper-flo™. It is used in HVAC&R applications for flux-free brazing of copper pipes, tubes and seams where these properties and its cost are acceptable. It is also used in some electrical engineering and plumbing applications.

Properties	Product Forms
-50 / 150˚C	
2 Flow	
Medium-Low	
0.05-0.2 mm	
740˚C	

SIL-FOS™ & COPPER-FLO™

products

silver/copper-phosphorus brazing filler metals

These products are mainly used for brazing copper to copper. They are self-fluxing on copper and therefore do not require a separate flux for this application.

	Specification	Description	Properties	Product Forms
Copper-flo™	Cu: 92.2 / P: 7.8 **Melting Range** 714-810˚C **EN1044: 1999** CP201 **ISO 17672:2010** CuP 182	Copper-flo™ is the most free flowing copper-phosphorus filler metal, however, due to its high phosphorus content it is one of the least ductile. It is best suited for making copper joints of the true capillary type and should not be used in applications involving exposure to strong vibrations, impact loads or where some deformation of the joint might be expected in service.	-50 / 150˚C – Flow Medium-Low 0.025-0.075 mm 720˚C	
Copper-flo™ No.2	Cu: 92 / P: 6 / Sb: 2 **Melting Range** 690-825˚C **EN1044: 1999** CP301 **ISO 17672:2010** CuP 389	Copper-flo™ No.2 is a specialised copper-antimony-phosphorus filler metal. It was specifically designed for flux-less brazing of copper cylinders for domestic and industrial heating systems where it is used for seam joints. The antimony in this filler metal improves its flow characteristics whilst allowing the phosphorus level to be kept low hence optimising ductility.	-50 / 150˚C – Flow Medium 0.05-0.2 mm 740˚C	
Copper-flo™ No.3	Cu: 93.8 / P: 6.2 **Melting Range** 714-890˚C **EN1044: 1999** CP203 **ISO 17672:2010** CuP 179	Copper-flo™ No.3 is a low cost, relatively ductile filler metal (when compared to Copper-flo™), which is not too fluid when molten so can be held in the joint area when brazing. These characteristics make Copper-flo™ No.3 a popular choice for air-conditioning and refrigeration applications. Where greater ductility is required Sil-fos™ 5 should be used.	-50 / 150˚C 3 Flow Medium-Low 0.05-0.2 mm 760˚C	
Stan-fos™	Cu: 86.2 / P: 6.8 / Sn: 7 **Melting Range** 640-680˚C **EN1044: 1999** CP302 **ISO 17672:2010** CuP 386	Stan-fos™ is not self-fluxing on copper and must be used with a brazing flux such as Easy-flo™ Flux Powder. It is free flowing and produces a smooth fillet. Stan-fos™ is brittle/not ductile and should therefore not be used in applications involving exposure to strong vibrations or impact loads. It is used primarily on copper to copper alloy joints.	-50 / 150˚C 1 Flow Low 0.025-0.075 mm 700˚C	

SIL-FOS™ & COPPER-FLO™

technical

recommended uses for sil-fos™ & copper-flo™ filler metals

Copper to Copper

Sil-fos™ & Copper-flo™ brazing filler metals are most often used to braze copper to copper. The phosphorus within the filler metals gives them a self-fluxing capability. There is therefore no need for a separate brazing flux.

Specific Issues for Copper to Copper	Recommendations
Tough-pitch copper is subject to deterioration if heated to a high temperature in reducing conditions. It contains dissolved cuprous oxide, which may be chemically reduced in a reducing flame or atmosphere to leave small cavities in the metal.	This effect is known as hydrogen embrittlement. When brazing this material a neutral or slightly oxidising flame is therefore recommended. Phosphorus de-oxidised or oxygen-free copper should be specified.

Copper Alloys

Sil-fos™ & Copper-flo™ products can be used to join copper alloys such as brass, bronze or gunmetal.

Specific Issues for Copper Alloys	Recommendations
A separate flux is required because the self-fluxing action only occurs on copper.	Easy-flo™ Flux Powder or Easy-flo™ 100 Flux Paste. Easy-flo™ Low Temperature Grade Flux Paste also performs well on copper alloys. Tenacity™ No.4A Flux Powder may be used where long heating cycles are required.

not recommended for

Brazing of Parent Materials Containing Iron or Nickel

Sil-fos™ & Copper-flo™ products should not be used to braze any iron or nickel containing materials including carbon and stainless steel.

Specific Issue: Metals Containing Iron or Nickel	Recommendations
The phosphorus within the filler metal will form brittle, intermetallic, phosphide compounds at the joint interface. This will cause complete failure of the joints.	Silver-flo™ or Argo-braze™ products may be suitable for these applications, consult Johnson Matthey for more information.

Sulphurous Atmospheres at Elevated Service Temperatures

Sil-fos™ & Copper-flo™ products are not suitable for use in sulphurous atmospheres at elevated service temperatures.

Specific Issue: Sulphurous Atmospheres at Elevated Service Temperatures	Recommendations
Phosphorus containing filler metals should not be used in cases where they will be exposed to sulphurised gases at elevated temperatures, for example in model engineering boilers.	Silver-flo™ or Argo-braze™ products may be suitable for these applications - consult Johnson Matthey for more information.

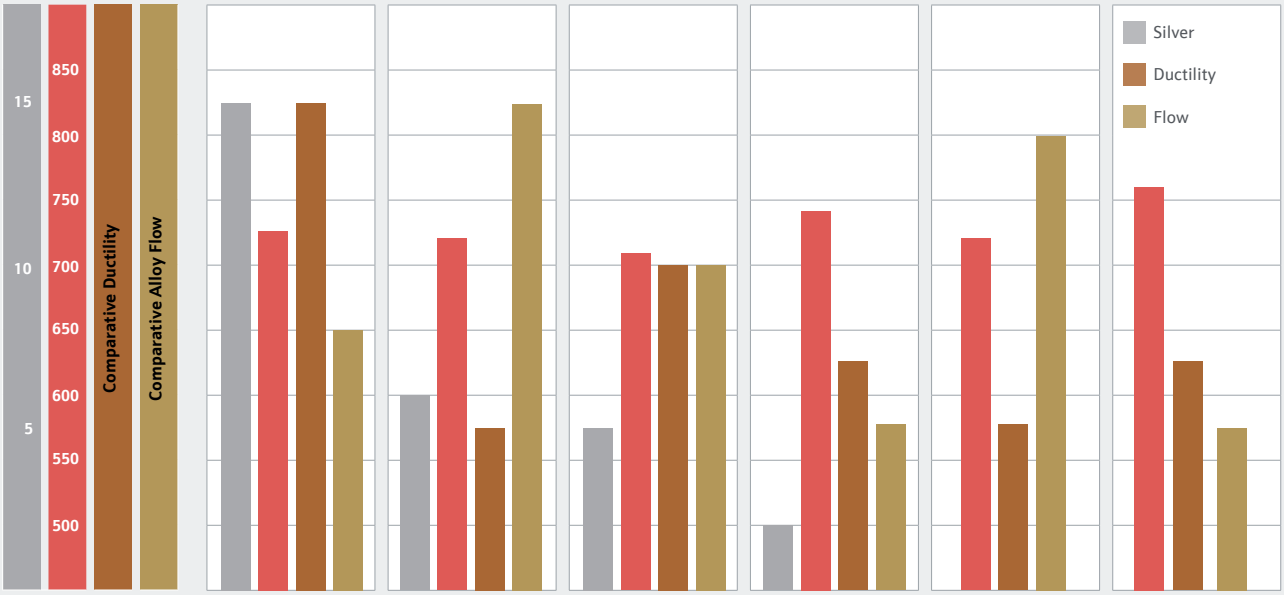
SIL-FOS™ & COPPER-FLO™

filler metal selection

When selecting a brazing filler metal from the Sil-fos™ & Copper-flo™ range it is necessary to understand about the flow and ductility of the different products. Silver and phosphorus are the key elements.
Silver is used to improve the filler metal's ductility but increases its cost.

The higher the phosphorus content the more free flowing but less ductile the filler metal becomes.
The relationship between these elements is shown below.

The Cost-Ductility-Flow Relationship



Property	Sil-fos™	Sil-fos™ 6	Sil-fos™ 5	Silbralloy™	Copper-flo™	Copper-flo™ No.3
Silver %	15	6	5	2	0	0
Working temperature ˚C	700	720	710	740	720	760
Comparative ductility	High	Low[1]	Medium	Medium - Low	Low[1]	Medium - Low
Comparative alloy flow	Medium	High/free flowing	Medium	Low[2]	Medium	Low[2]
Comparative cost	High	Medium	Medium	Medium - Low	Low	Low
Typical applications	Electrical	HVAC & R	HVAC & R Heat exchangers	HVAC & R	HVAC & R Heat exchanger return bends	RAC[3]

[1] Not suitable for use on joints which will be subjected to strong vibrations, impact loads, manipulation or deformation after brazing or in service [2] Low flow make these alloys a good choice for situations where the filler metal needs to be kept in the joint area and must bridge a wide gap. [3] Refrigeration and Air Conditioning.

SIL-FOS™ & COPPER-FLO™

Elements

Ag	Silver
Cu	Copper
Si	Silicon
Sn	Tin
Zn	Zinc

Properties

1	Free flowing filler metal when molten
2	Medium flowing filler metal when molten
3	Sluggish flowing filler metal when molten
	Optimum joint gap
	Tensile/shear strength Mpa
	Working temperature

Key to Product Availability

The product description charts in this book indicate which products are readily available from stock at the time of this brochure being printed. If a product is indicated in a lighter shade it can be supplied to order.

Standard Forms of Supply

	Foil
	Paste
	Powder
	Preform
	Ring
	Rod
SO	Special Order
	Strip
	Wire

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