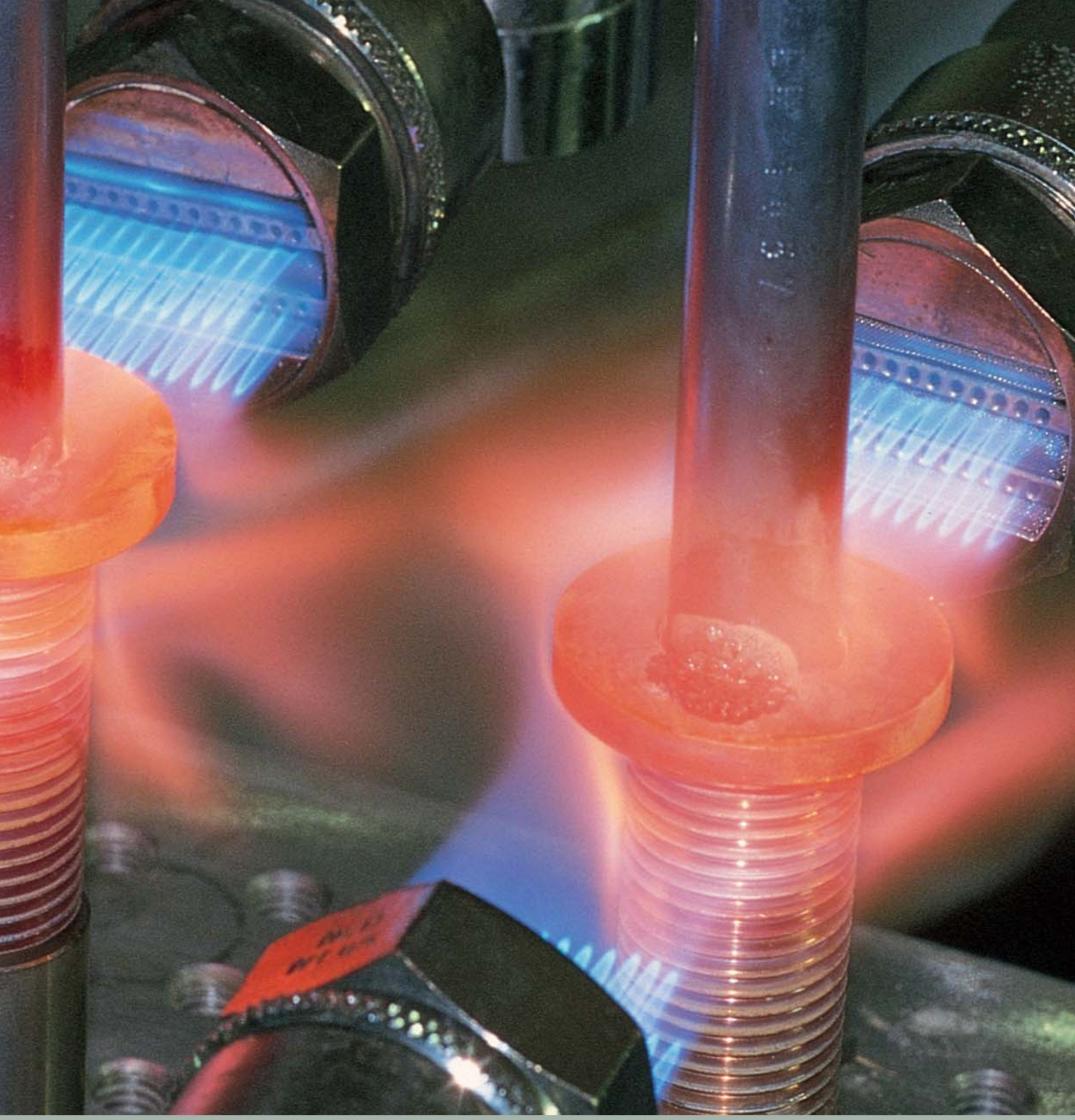

Johnson Matthey Metal Joining - Brazing and Soldering Pastes

Introduction

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Johnson Matthey Metal Joining

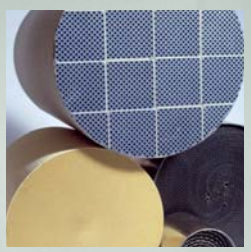
What are Brazing and Soldering Pastes?

A Johnson Matthey brazing or soldering paste consists of a filler metal alloy in powder form and where appropriate a flux. These components are held together in a uniform paste by a specially formulated binder system.

The end product is a custom made brazing or soldering solution that can offer unique benefits to Johnson Matthey's customers.

In particular brazing and soldering pastes are used in production where there is a need to manufacture large numbers of joints.

The benefits to be gained by using a paste product for soldering or brazing can often only be achieved with the full support of technical teams that understand the products. Johnson Matthey is well placed to offer this support globally.



Johnson Matthey Plc

Johnson Matthey is a speciality chemicals company and world leader in all aspects of precious metals technology and catalysts. Building on almost 200 years of expertise in assaying and refining, the name of Johnson Matthey has become synonymous with the highest levels of quality and customer service.

Johnson Matthey has continued to develop new technology, demonstrating its ability to adapt constantly to the ever-changing needs of customers.

The Company has a long-term commitment to investment in research and development, as well as in new manufacturing technologies. Today the Company employs around 7,500 people in 34 countries across the globe and its principal activities reflect its core skills.

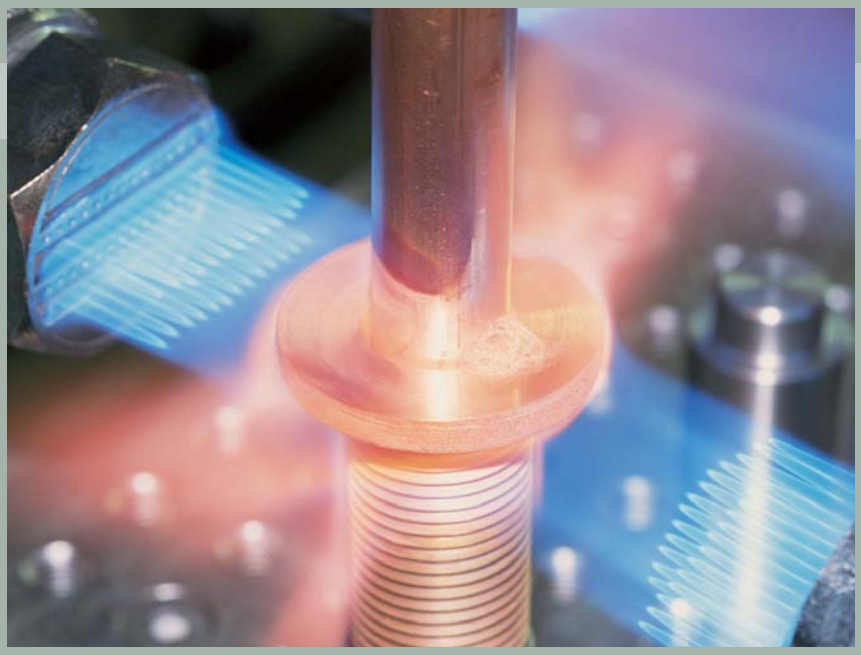
About Johnson Matthey - Metal Joining

Johnson Matthey has over 70 years experience in the brazing and soldering industry. The knowledge that we have accumulated, coupled with the experience of our technical staff and broad product range, means that we are able to offer the best technical advice and support on metal joining.

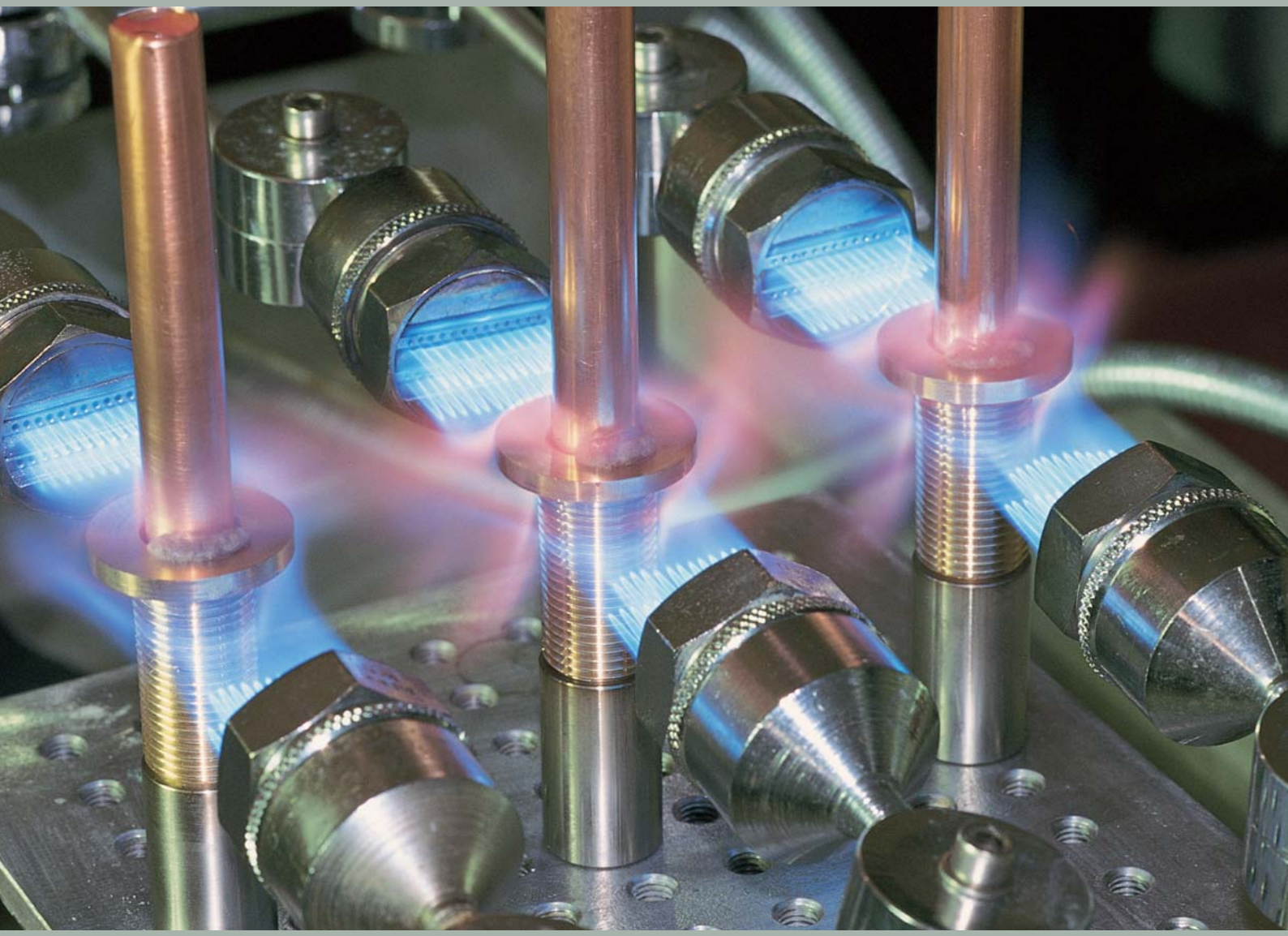
Johnson Matthey Metal Joining operates a BS EN ISO 9001:2000 Quality Management System. This ensures continuous improvements throughout the business and is approved by the UKAS accredited Lloyds Register Quality Assurance.

Johnson Matthey Metal Joining also holds a number of customer approvals including several from the aerospace industry.

The Benefits of Using a Johnson Matthey Brazing or Soldering Paste



Cost Saving	Automation	Flexibility
Like filler metal rings and washers, brazing and soldering pastes can allow tight control over the amount of material used. With paste products the ratio between flux and alloy can be optimised. Paste also allows single step deposition of flux and filler metal. These features provide cost savings and can lead to improved quality control and joint appearance.	Use of brazing or soldering paste can open the way for automating or semi-automating a joining process. This can have the benefits of improving quality and productivity as well as 'de-skilling' the joining process.	Brazing and soldering pastes offer great flexibility in terms of the way in which they can be made to behave before and during heating. This means that they can be used on a wide variety of applications and under different circumstances.
The automatic brazing of heating elements became significantly more cost effective because of a move away from using a wire feed and flux process to using brazing paste.	*One major manufacturer of circular saw blades has found that by using a JM brazing paste rather than foil and flux they have simplified their brazing machines, thereby improving quality and productivity.*	*Johnson Matthey have supplied pastes that are suitable for dispensing tiny deposits onto small components, larger deposits on long straight, curved or contoured joints and for stencilling over large areas.*



Economy	Versatility	Health and Safety
Pastes can be applied either as a dot, a stripe, or as any shape over a joint. This can reduce cost where otherwise an experienced operator or several expensive preforms would be required. One brazing or soldering paste can replace many sizes of preforms. This enables prices to be based on larger volumes of one product. It also reduces stock levels and time-consuming materials control.	Pastes can sometimes be produced where hard form filler metal products such as rods, wires or rings are not available. Powder production technology allows a very wide range of alloys to be made, even in small quantities. This means that Johnson Matthey is able to offer a solution to the customer's joining requirements using a paste product.	Pastes have the flux incorporated into the product. They can be applied from airtight containers and dispensing equipment. This means that they can reduce the contact between operators and flux chemicals as well as providing a cleaner working environment.

One manufacturer of industrial switchgear has made savings by using a JM brazing paste rather than using foil and flux or more expensive solder backed contact patches.	*Nickel based brazing filler metals can be supplied as pastes but are generally too brittle to be supplied in solid form wire or as preformed shapes.*	*Many customers report that their workplaces are cleaner and that operators are happier using pre-packaged pastes that they do not have to handle.*

Application Profile for Brazing and Soldering Pastes

Industrial grade solders for electrical components

Aluminium automotive components

Brazing of electrical contact tips in switchgear

Brazing of tungsten carbide tips on saw blades

High impact tungsten carbide tipped drill bit

Aerospace controls and sensors brazed with palladium based pastes

Hydraulic fittings and automotive components

Nickel based alloys for automotive and aerospace components

Product Applications

Soldering and Brazing Pastes have been successfully adapted across a broad range of industrial applications. Pastes have enabled sound joints to be made from small-scale high quality work to mass production where high yields of good quality components are essential.

Aero engine parts brazed with gold based pastes

Temperature Profile for Brazing and Soldering Pastes

Joining Processes

Paste technology has been successfully applied across the range of soldering and brazing materials available today. Pastes have been used in all of the alloy groups shown above.

The Paste Product Range – Filler Metals, Fluxes and Binder Systems

A brazing or soldering paste consists of a filler metal in powder form held in suspension by a binder system. The binder system may or may not contain flux depending on the filler metal and the heating method being used.
When Johnson Matthey specify the paste for a particular application a number of factors are considered.

1. The Choice of Filler Metal

The choice of filler metal in a paste follows the same guidelines as for solid forms. Whilst most brazing and soldering alloys can supplied as paste it is advisable to consult JM for more details on product availability before specifying an alloy on drawings etc.
JM Technical staff will assess a number of factors before recommending a filler metal type.

These include: - Parent metals to be joined, component type and function, service requirements and environment, heating methods, production requirements, joint gap and configuration.
Pages 8 and 9 of this booklet show the JM paste product groups whilst pages 24 and 26 show the specific alloys available.

2. The Binder Systems

The function of the binder is to hold the alloy powder and flux in a stable suspension allowing the paste to be dispensed consistently. When selecting the appropriate flux type and quantity it is important to consider factors such as heating method, soldering or brazing time, temperature and parent metals to be joined.

The tables on pages 11-13 show the standard types of fluxed and flux free binder systems available for both brazing and soft soldering applications. The most commonly used binder systems of each type are identified. Development, reformulation and modification of binder systems to meet the specific requirements of individual applications is common practice with JM paste products.

3. The Percentage of Filler Metal in a Paste

The metal content of a paste varies according to application and heating method. Johnson Matthey technical staff will help select the appropriate level. Typical figures are shown below.

Soft Soldering (with flux binder)	Air Brazing (with flux binder)	Furnace Brazing (flux-free binder)
75 - 88%	65 - 75%	80 - 90%

4. Brazing and Soldering Alloy Powders – Particle Size

JM pastes can be supplied with a variety of different alloy particle sizes. Finer powder results in a smoother paste that can be dispensed in smaller deposits. Standard sizes are shown below.

Standard JM powder sizes	
Soft Solders for Industrial Applications	-106 microns
Aluminium Brazing Alloy	-106 microns
Silver Brazing Alloys	-180 microns
Palladium, Gold and Copper Based Brazing Alloys	-75 or 53 microns
Nickel Based, Brass and JM Bronze™ Brazing Alloys	-106 microns

5. Viscosity of Paste

All JM pastes can be formulated so the viscosity is controlled to a consistency suitable for the component and the paste application method.

Binder Systems for Soldering Pastes

These binder systems are intended for use in industrial and electrical soldering applications only. They are not designed for soldering of electronic components.

Flux-Binder Type	Working Range °C	Comments
Binder systems containing rosin based 'non-corrosive' residue fluxes. S3 and S100 are examples.	130-315	Binder systems containing rosin based fluxes are available as 'RMA' systems without 'activation' and only trace halide content or with various levels of 'activation' from 'RA' (0-0.5% halide content) to 'HA' (typically 1% halide content). Fluxed binder systems in this group are only suitable for soldering copper and brasses. The ability of these binder systems to solder a brass will depend upon the level of activation used within the flux. Residues from these systems are non-corrosive and may be left on components.
Binder systems containing 'intermediate' type fluxes. S1 and S5 are examples.	150-270	Intermediate soft soldering fluxes are formulated from a wide range of different compounds and substances. They are significantly more active than the rosin based fluxes but tend to have short lives at soldering temperature. Depending on the flux composition, they can be susceptible to decomposition, volatilisation, charring or burning. For this reason gentle, controlled and indirect heating is recommended. The flux residues left after soldering can range from relatively inert to quite corrosive. Generally they can be easily removed by washing with water.
Binder systems containing 'corrosive' type fluxes. S8 is an example.	175-325	The 'corrosive' type soft soldering fluxes provide the highest level of fluxing action and can deal with the most tenacious oxide films. These systems are based on inorganic chloride and fluoride salts and acids. They can be used on all types of parent material, but are mainly used when soldering mild or stainless steels. The flux residues are corrosive and need to be removed to prevent subsequent corrosion of the joint and surrounding parent material. Special cleaning methods may be necessary, but washing in warm water is sufficient in most cases.

Binder Systems for Aluminium Brazing Pastes

This range of flux-binder systems has evolved largely for the manufacture of automotive components, heat exchangers and cookware products.

Flux Type	Working Range °C	Comments
Non-Corrosive	500-600	General purpose aluminium flux binder, which leaves non-corrosive flux residues that are fluoride based, insoluble in water and have to be left on the joint.
Corrosive	500-600	General purpose aluminium flux binder which gives corrosive flux residues that are chloride based and must be removed with a hot water wash. Specific flux binder systems are available in this category for fluxing on aluminium alloys that contain up to 4% magnesium.

Binder Systems With Flux for Silver and Copper Based Brazing Alloys

This fluxed range of binder systems is designed for use with silver and copper based filler metals when brazing in air.

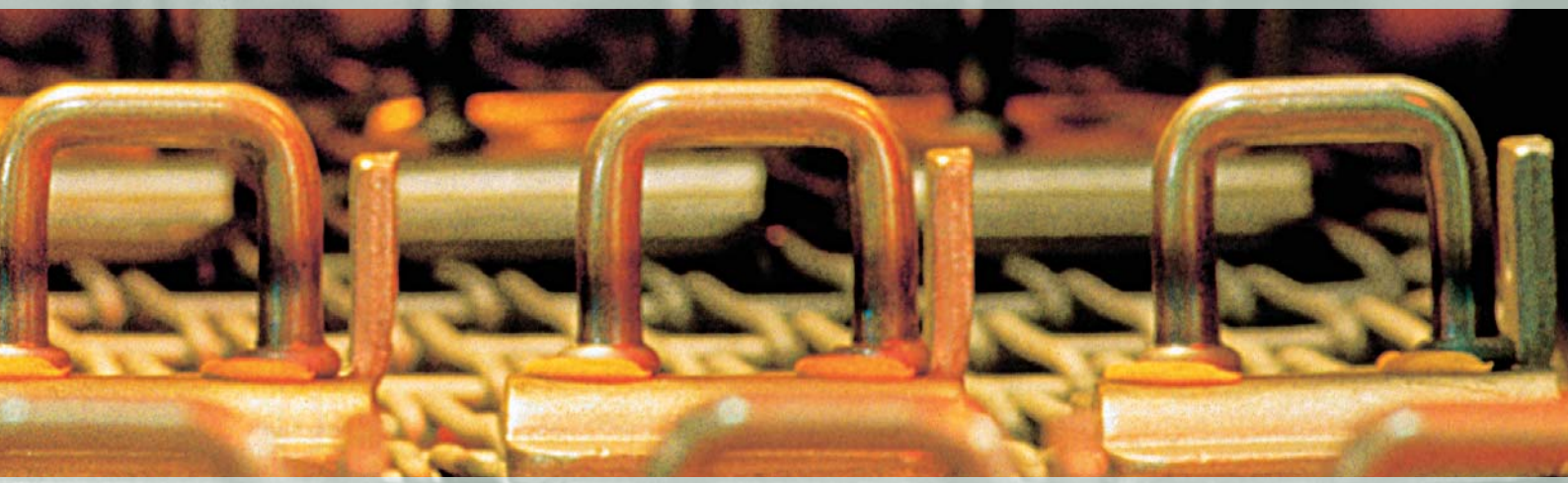
The JM Metal Joining Paste Product Range - Binder Systems

Binder Type	Working Range ˚C	Comments
Non-slumping, low temperature, semi restrictive fluxing action for use with silver based filler metals. B1 and B10 are examples.	540-875	This group of fluxed binders are the standard, general purpose systems used in conjunction with most silver brazing filler metals. The binder systems are 'non-slumping' and will remain stable during heating apart from some slight inflation. The stability of this type of binder system allows paste deposits to be hung on vertical surfaces where no real shelf exists on which to place a paste deposit. The fluxes used within these binder systems are of the fluoroborate type. Flux compositions and the percentage of flux used within the binder systems can be varied to develop particular characteristics or paste behaviour.
As above but containing boron modified fluxes. B2 and B13 are examples.	540-950	A special addition that can be made to any of the standard types of fluxed binder systems mentioned above is that of elemental boron. The boron makes the fluxes highly active against those elements that form refractory oxides such as chromium, molybdenum and tungsten. These flux binder systems are therefore nearly always specified for brazing tungsten carbide. The boron addition also increases the ultimate working temperature of the flux and its time / temperature stability.
Fluxed binder system for use with manganese bearing filler metals. CRF is an example.	600-920	A specially formulated boron modified flux binder system used with manganese containing filler metals such as Argo-braze™ 49H and 49LM. Pastes formulated using these filler metals are used for the brazing of tungsten carbide.
Binder systems containing high temperature fluxes. FRF B11	750-990 750-1250	These fluxed binder systems contain high temperature borate based fluxes and are used for air brazing applications, with low silver or copper based filler metals. Used typically with the brass based filler metals. Used typically with the JM Bronze TM filler metals.

Binder Systems for Furnace Brazing Applications

Binder Type	Working Range ˚C	Comments

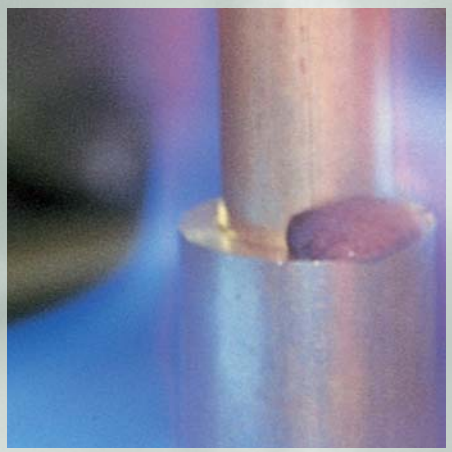
Water soluble polymer gel systems. B5, B7 and B8 are examples.	> 1000	The standard type of binder system used for reducing atmosphere or vacuum brazing with high temperature filler metals such as copper, JM 'B and 'C' Bronze TM and the Nickelbraze HTN alloys. Binder system characteristics can be modified by use of different polymers. Changing the amount of polymer and other special additives can minimise cold slump of the paste deposit and rate of drying. In general the binder systems do not suffer from hot slump and adhere well to the parts during heating. These systems tend to leave little or no residue in most types of reducing atmospheres and vacuum. In high hydrogen, low dew point atmospheres some residues may remain. These residues can generally be eliminated by modifications to the paste formulation.
Hydrocarbon based systems B4 and B4A are examples.	< 1000	For use with filler metals having brazing temperatures below 1000˚C such as Argo-braze™ 72V, most Pallabraze™ alloys, silver brazing alloys and carat gold solders. These binder systems can be used in both reducing atmosphere and vacuum brazing furnaces where systems leave minimal residues. Modified binder systems exist that are suitable for screen printing or stencilling. Most systems tend to exhibit some degree of hot slump on heating.
Partially fluxed furnace binder systems		In some cases a hydrogen containing atmosphere is not sufficiently reducing to remove the oxides present on the filler metal and or parent metals. In these cases small additions of flux can be made to the above system to promote filler metal flow and parent material wetting. Binders of this type are commonly used with silver brazing filler metals and carat gold solders.

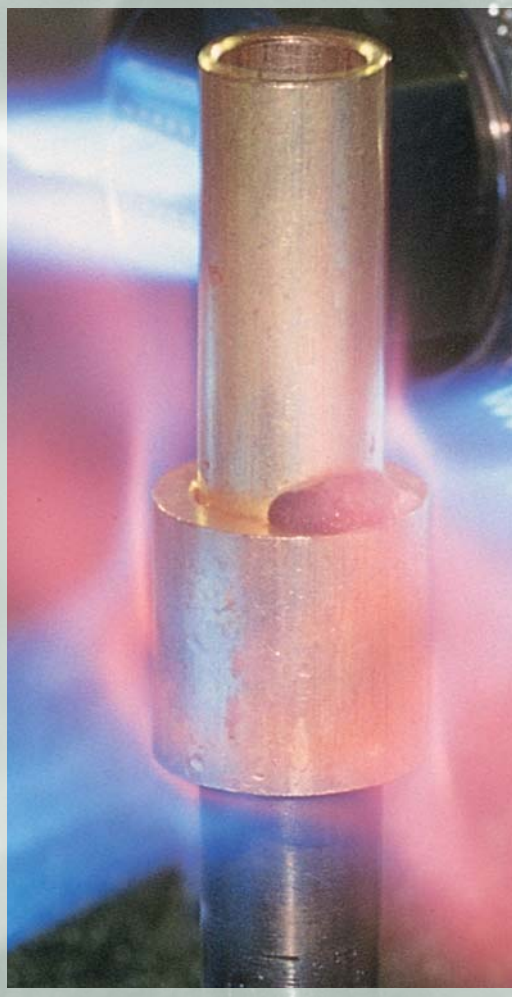


How to Use Brazing and Soldering Paste

Dispensing and Positioning of Paste

The use of paste requires different techniques and general practices to those employed for other forms of brazing or soldering consumables. The basic principles of joint design with a close capillary gap, degreasing of parent metals, correct heating technique, residue removal and safety requirements will always apply.





Location of Paste Deposits

Whilst no particular joint design is excluded from brazing or soldering with paste, the suitability of a component is dependent on there being a place to deposit the required amount of paste. Ideally the component should have a shoulder or ledge on which the deposit of paste can be adequately supported.

The following general principles give guidance on the location of paste deposits					
1	Wherever possible components should be assembled and the paste applied externally and as near to the mouth of the joint as possible.	**2**	Placing of paste within the joint should be avoided because the binder may not burn off completely. This will restrict the flow of flux and alloy and could increase porosity in the joint.	**3**	If the component does not have a convenient shoulder or ledge on which to support a paste deposit, then it should be applied above the joint. Any movement of the deposit during heating can be controlled to direct the flux and alloy flow towards the mouth of the joint. In this case a flux binder system with minimal slump characteristics will be prescribed.

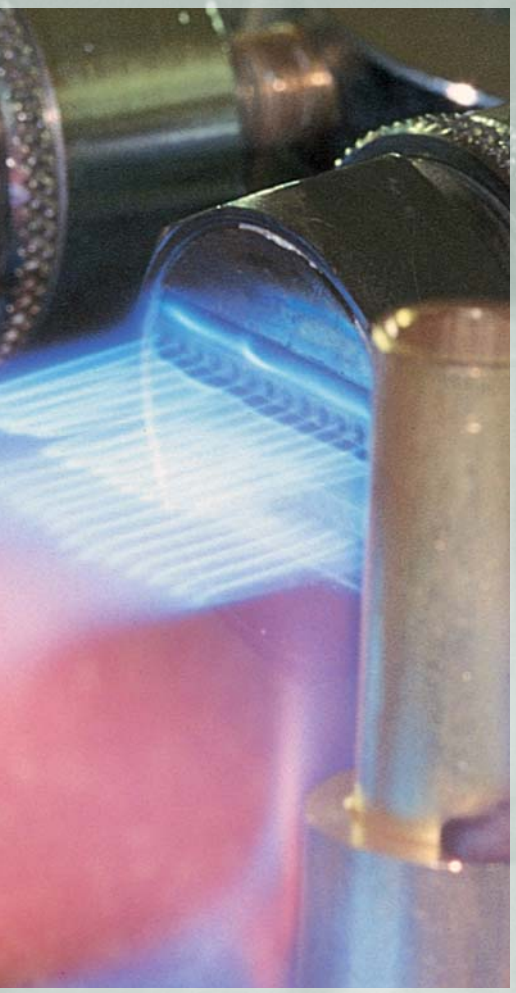
Dispensing of Paste onto Components

A major advantage of using a paste is that it can be dispensed in accurate and controlled volumes, ensuring that a particular joint receives the same amount of paste on each application.

Paste is often supplied in cartridges, which can be fitted to accurate air operated dispensing machines. Where larger volumes of paste are required a reservoir connected to a paste gun can be used. Details of standard dispensers, reservoirs and cartridge filling devices are shown in this booklet on page 22.

Paste can be supplied in hand cartridges for manual dispensing although this reduces the close control over paste volumes achieved with even the most basic dispenser.

Paste can be specially formulated so as to enable it to be applied to a component in a number of different ways. Consult a JM technical representative about the most suitable method for dispensing paste onto a particular component. The paste will then be formulated accordingly.



The Size and Shape of Paste Deposits

The shape and design of the component govern the size and placement of the paste deposit. It is often possible to calculate an approximate amount of paste required per joint. However, in most cases a simple production test will quickly establish the correct amount to use.

For automatic dispensing the following points should be considered					
1	If possible paste should be applied as a single deposit. This method needs the minimum of dispensing equipment and the least time spent on the dispensing operation.	**2**	On long joints it may be necessary to apply more than one paste deposit. This increases the area covered by flux and alloy and is advisable particularly if the alloy is not free flowing.	**3**	Paste can be applied as a number of dots, or as a continuous stripe. On bigger components, with a limited shoulder to support a single large paste deposit, a series of dots or a stripe may be necessary to provide sufficient paste to complete the brazed joint. In applications such as this, movement of either the dispensing nozzle or the component itself may be required during paste application.

How to use Brazing and Soldering Paste

Heating Methods

JM Paste products can be used successfully with most of the standard heating methods.
The most common are listed here.

Fixed Burners

With fixed burners the requirement for operator skill and experience can be overcome and a correct, reproducible heat pattern can be found for most components.

Ranges of burners are available using a variety of fuels from gas / air through to oxygen / gas systems. The final choice of fuel is usually based on availability together with size of components and required production rates.

Fixed burners can be used as simple arrangements of single or double burners, on basic shuttle machines or on rotary indexing machines. The burners and heating cycles can ultimately be controlled by pc systems.

Furnace Heating

Pastes can be formulated to suit the requirements of most furnace brazing or soldering applications.

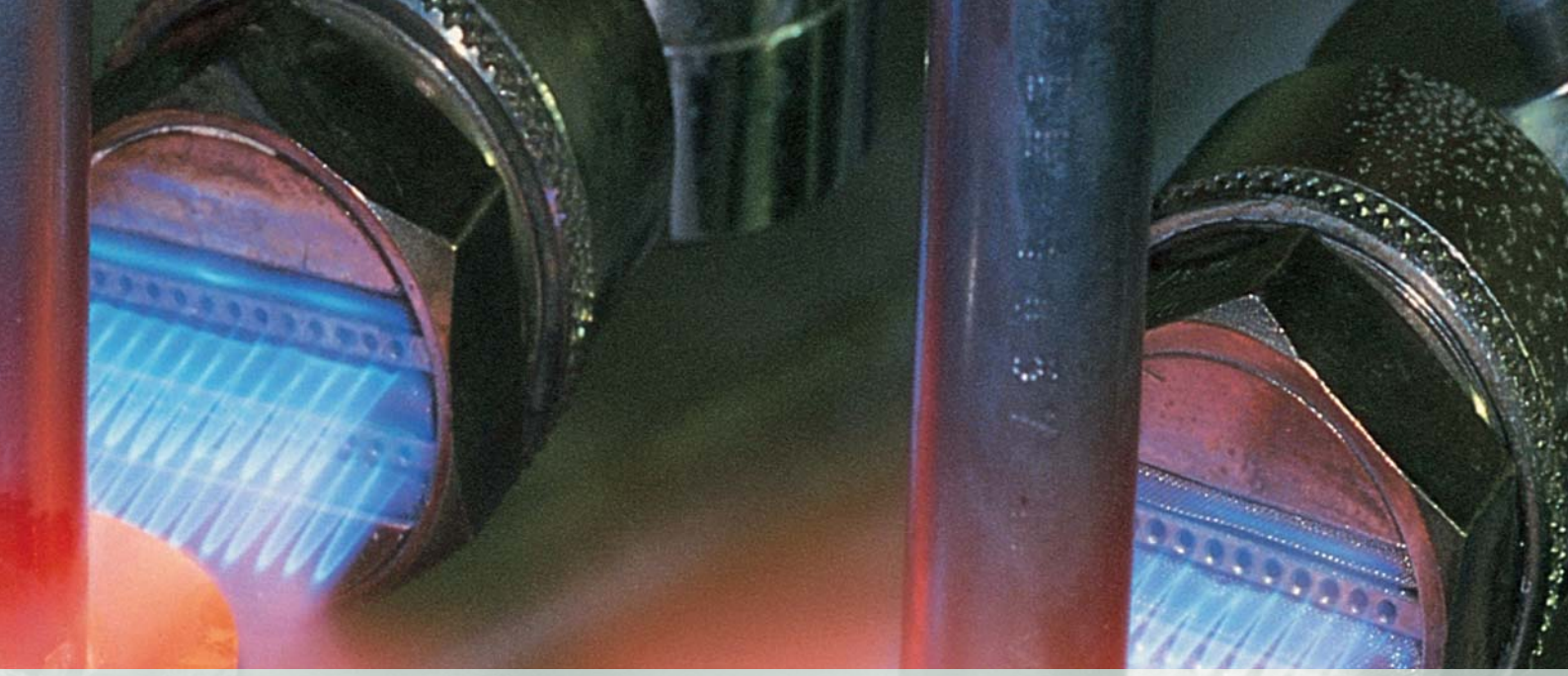
Furnace heating is widely used for brazing. It uses a reducing atmosphere or vacuum to remove or break up surface oxides and prevent their formation during the brazing process. Furnace brazing is usually a flux free operation. If the oxides present on the parent metals are particularly difficult to reduce then a small amount of flux may be added to the paste to improve cleaning and wetting of the molten alloy.

During furnace brazing the whole component will reach brazing temperature. Pre-placement of the filler metal prior to heating is required. For this reason the position of the paste deposit and its properties are particularly important.

Induction Heating

Brazing and soldering pastes are widely used with this heating technique. It provides quick and easily controlled heating. Occasionally rapid heating of the component may cause the paste to move or spit due to vaporisation of the binder. This can be overcome by moderating the power input or modifying the design of the induction coil.

Once conditions are set, induction offers an efficient heating method, which gives a heat pattern well suited to paste products.



Resistance Heating

Brazing and soldering pastes work well with resistance heating methods. Resistance heating with a separate alloy and flux can cause problems because the flux acts as an insulator. With paste this is largely overcome because the finely divided powder offers a conductive path through the flux.

Pastes with a high metal content are specified in conjunction with a flux that becomes active very quickly since the fast heating rate reduces the time for the flux to be effective on the parent metals.

Hand Torch

Paste is suitable for heating by hand torch. Operators experienced in brazing or soldering with separate rod and flux will need to modify their brazing technique when using paste.

When hand torch brazing the operator will normally heat the joint area directly with the flame to reach brazing temperature as quickly as possible. Pastes should be heated indirectly rather than with the full torch flame. This is because the deposit if heated directly, will reach brazing temperatures long before the parent metals. In this case the flux in the paste will not have sufficient time to clean the parent metals and the molten alloy will not wet out onto the joint area. In the worst case the molten alloy may ball up and roll away from the joint.

Heating the paste indirectly will allow the paste deposit to reach the correct temperature at the same rate as the rest of the component. In this case the flux will function correctly. The overall heat pattern should ensure that a temperature gradient exists in the joint area so that flux and molten alloy will flow into the joint.

How to use Brazing and Soldering Paste

Heating Brazing Paste

The behaviour and flow characteristics of a brazing paste when heated will depend upon its formulation, whether it contains flux and the heating method being used. A typical fluxed paste for brazing in air with a silver brazing filler metal based around the 'B1' binder system will go through the following stages.

1	On initial heating the paste deposit will increase in size. During this early stage of heating the paste deposit should be heated slowly and indirectly to cause it to 'set'. Heating it too rapidly or directly at this stage can cause it to 'explode' or spit. Slow controlled heating is especially important if the paste has been hung on a vertical surface.
2	With further heating, the paste will either start to smoke significantly, or if a flame is present will ignite. Where ignition of the paste does not occur, for example when using RF induction or resistance heating, local exhaust ventilation should be used to remove the fume from the working environment.
3	As the heating continues the paste's appearance will change from a shiny, glossy deposit, to a dull, dry one. The binder has now been lost from the paste which has become 'set'. Once 'set' it is stable and can be subjected to a more rapid rate of heating.
4	Next the flux starts to melt, 'wetting' the parent metals and reducing surface oxides on them. Initially this takes place locally around the base of the paste deposit. As the temperature continues to increase the flux becomes more fluid, spreading out and flowing into the capillary gap present within the joint.
5	Finally, as more heat is applied the filler metal will begin to melt and then flow completely. The rate of heating at this stage needs to be sufficient to prevent liquation of the filler metal. This is where the filler metal only partially melts leaving behind a skull of solid material and resulting in a joint that is only partially filled.

Brazing pastes can be supplied that exhibit different characteristics to these during the heating cycle. Both the binder and the flux in a paste can be changed or modified to match the needs of a particular brazing job. For example binder systems can be supplied that collapse and spread onto a component where paste is needed over a large area.

Removal of Brazing Paste Residues after Heating

The flux residues of brazing pastes are corrosive and therefore their removal after brazing is essential. They are similar to those generated in other brazing operations and may be removed by the same methods - soaking in hot water (> 40˚C for 30 minutes), soaking in 10% sulphuric acid or by mechanical removal (e.g. grit blasting). The method should depend on the type of flux present. Brazing pastes often leave a 'footprint' or mark on the component that is difficult to remove after brazing.

For advice on the best method of removing the flux residues please consult Johnson Matthey.

Heating Soldering Paste

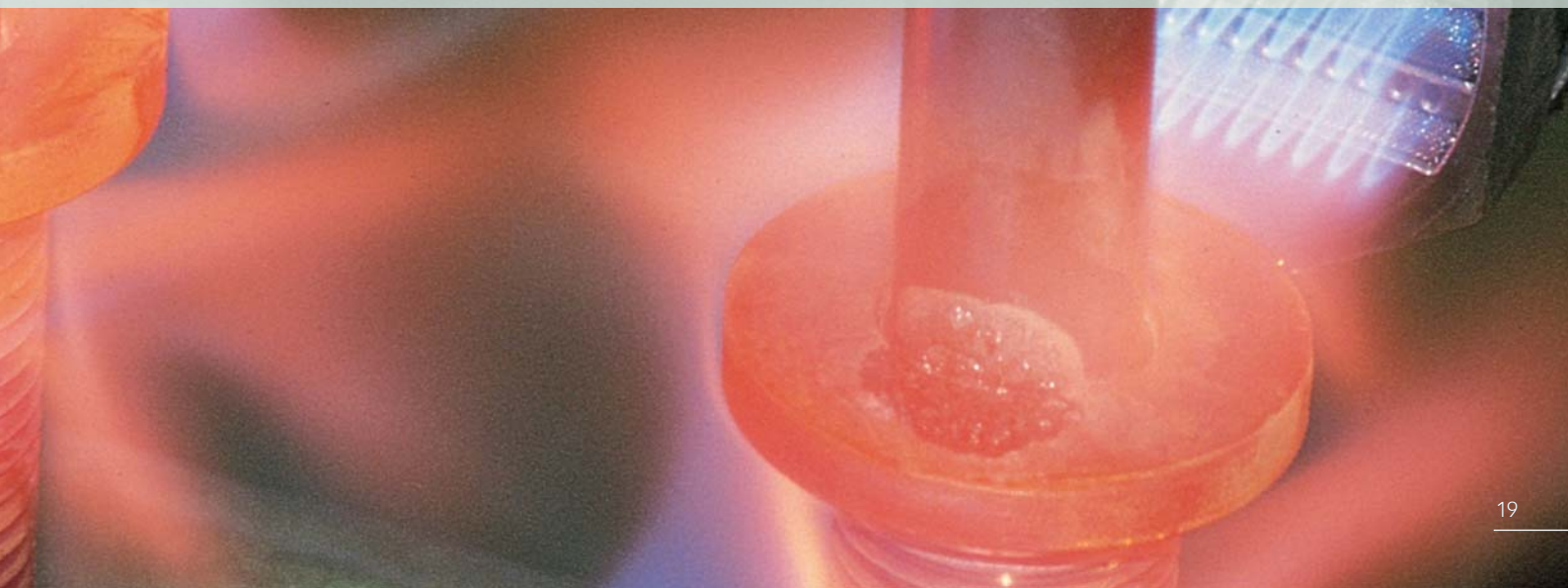
Solder Pastes are formulated around totally different binder systems and flux types to those used for brazing and they therefore react completely differently to brazing pastes when heated.

1	All solder paste when heated initially will exhibit some slump depending upon its formulation. With further heating the deposit may bubble and heave (foam) and begin to smoke. Local exhaust ventilation to remove the smoke from the working environment should be used. If heated too rapidly the paste deposit can boil and spit. Gentle, indirect heating of solder paste is recommended throughout the soldering process. For this reason hot air heating is a very good method for use with solder pastes.
2	With most binder systems the flux spreads and flows as the soldering paste slumps during heating. It becomes more fluid as the temperature is increased and should remain colourless throughout the soldering operation. If the flux starts to go brown it is an indication that either it is beginning to become exhausted or that the paste has been overheated.
3	As the solder alloy within the paste begins to melt, the flux is displaced from the joint and floats on top of the molten solder. Fluxes and solders will always flow to the hottest point of a joint and further flow of the solder, into, along or around the joint can be encouraged by creating a thermal gradient across it. The temperature should not be increased too much as this could induce flux exhaustion and the generation of fume.
4	If the solder fails to wet and flow as required or forms a molten 'ball' then this is an indication that the flux has not been able to remove the oxides present on the surface of the parent materials. This could be due to exposing the paste deposit to too high a temperature or exhausting the flux before the filler metal becomes molten. Alternatively an inappropriate fluxed binder system was selected for the application.

Removal of Soldering Paste Residues after Heating

Flux residues from soldering paste are classified as non-corrosive, intermediate or corrosive. Non-corrosive residues may be left on the completed joint. Intermediate or corrosive flux residues should be fully removed. Warm water, mildly alkaline solution, or in the case of rosin based flux residues an organic solvent, should be used.

For advice on the best method of removing the flux residues please consult Johnson Matthey.

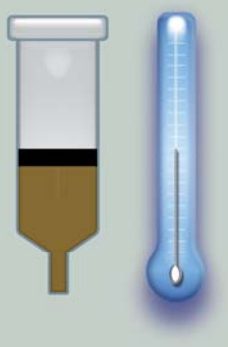


How to Use Brazing and Soldering Paste

Storing and Shelf Life

Brazing and soft soldering pastes have limited shelf life and strict stock rotation should be exercised during their storage. The binder system and the filler metal powder can separate and the paste may dry out during storage. Separation or drying out of a paste is more likely if the product is not stored correctly.

Storage Temperature



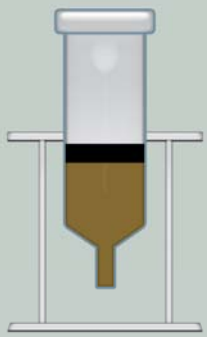
Braze and soft solder pastes should not be stored below 5˚C or above 25˚C. The ideal storage temperature for pastes is between 10 and 15˚C.

The viscosity of brazing and soft solder pastes is affected by temperature. They are designed for use between 18 and 24˚C (Viscosity measurements are taken during production at 20˚C).

If subjected to temperatures below 15˚C the paste viscosity will increase making dispensing more difficult. If stored at temperatures above 25˚C the paste will become very fluid and may separate and dry out. It is therefore recommended that pastes should be withdrawn from the storage facility some time before use and placed in the workshop environment to obtain a normal working temperature.

Storing at temperatures below 5˚C can result in damaging the products irreparably.

Storage Conditions

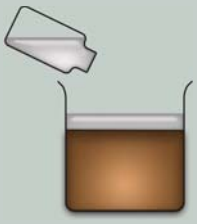


Paste should be ideally stored in cool dry conditions away from direct sunlight and other sources of heat.

Pastes supplied in buckets or pots should be stored in closed containers and stood with the lid upper most.

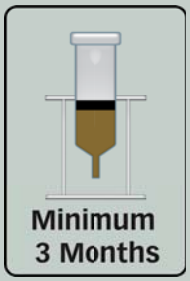
Pastes supplied in machine cartridges or hand syringes should be stored standing up in racks with the 'follower plug' upper most and the nozzle facing down. Storing cartridges / syringes on their side can result in separation of the paste.

Dried out Pastes



Pastes that have dried out and cannot be dispensed should not be reconstituted. Dedicated binder system thinners with specific properties are used to thin pastes in production to the correct work viscosity. Any attempt to reconstitute a product is unlikely to result in a paste that will function effectively.

Storage Conditions



The shelf life of braze and soft solder pastes will be affected by the type of binder system used to formulate the paste, the storage temperature, exposure to the air and the container size.

Pastes should only be considered unusable if they have dried out such that they cannot be dispensed easily and correctly or show signs of binder separation.

1 Machine Cartridges / Hand Syringes - Under ideal storage conditions pastes supplied in 100g cartridges / syringes will have a shelf life of a minimum of 3 months. A reduced life might be expected for small sized cartridges containing up to 10g and extended life for cartridges containing 500 to 1000g, but this will be dependent upon the storage conditions.

2 Buckets and Pots - For paste supplied in buckets and pots a minimum shelf life of around 6 months can be expected under ideal storage conditions.

As many pastes are thixotropic it is recommended that they be stirred before use. This reduces their viscosity, making it easier to dispense them. Pastes should be allowed to reach normal working temperature before being stirred.

Some separation of the thinners and binder system may occur when a paste is stored. Generally the separated liquid can be readily reincorporated into the paste by stirring it. If this does not bring the paste back to a suitable consistency then it is an indication that it has dried or settled out in storage and should be replaced.

Extending the Normal Shelf Life

Storing paste in a refrigerator between 5 and 10˚C will extend the shelf life by several months over that which could normally be expected, whether supplied in buckets, pots, cartridges or syringes. As previously indicated where paste is stored at low temperature it should be allowed to attain normal working temperature before stirring and subsequent use.

Dispensing Equipment

Johnson Matthey offers two standard forms of paste applicator systems.

JMMJ Paste Applicator

With Dispensing Kit

The JM applicator system kit can be operated from a hand or foot control to provide timed or continuous paste deposits. The kit comes complete with a variety of needles, an airline, 10cc and 30cc cartridges, cartridge adaptors and a foot control pedal. This system is ideal for precise deposits, dots, stripes or multiple deposits.

The air pressure can be controlled and the pasting function can be timed to provide the correct deposit of paste for each application.

Other forms of non-standard paste equipment or packaging are also available. Please discuss with the Technical sales team at Johnson Matthey Metal Joining.

JMMJ Paste Applicator

With Reservoir and Gun

The JM paste reservoir can be used for volume paste dispensing applications controlled by a control box and using the paste gun. It can be used as a cartridge-filling device by making some modifications. This is useful for applications where many cartridges are used and filling them by hand is not suitable.

The standard reservoir holds approximately 5 kilogrammes. The paste is kept under pressure and is dispensed down a tube to the gun. The paste gun is often mounted onto pneumatic slides or a clamp stand to enable the paste to be brought into contact with the components to be joined. The paste guns can be modified to give several nozzles from which multiple deposits of paste can be made. The stroke length on the gun can be altered, as can the time settings to control paste deposits.

Brazing Machines for Automation or Semi-Automation of the Joining Process

Johnson Matthey does not manufacture brazing or soldering machines of any type. A variety of options are available and most heating methods can be adapted for increased productivity and varying degrees of automation.

The Johnson Matthey Technical sales team is able to discuss options and offer impartial advice on the type of system that would best suit all the parameters of each application.

It is recommended that before buying a machine or furnace the joining parameters are discussed fully with Johnson Matthey and that trials are undertaken to prove the compatibility of the machine, its heating method and paste process.

Johnson Matthey represents Mahler GmbH in the UK. Mahler manufactures continuous reducing atmosphere furnaces for brazing and annealing. For more information contact Johnson Matthey.

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Some Guidelines for Using Pastes

Joint Design

- Do design joints so that there is a ledge or shoulder to place the paste deposit on.
- Remember that for sandwich style joints a foil may be a better option.

Dispensing

- Do not spread paste on a joint, position it at the mouth of the joint.
- Do stir paste before use especially if the paste is over 6-9 months old.
- Do not put the pressure up much above 30 psi. Excessive pressure could cause the paste to break down or block the nozzle.
- The ideal pressure range is 20 - 30 psi.
- Do remember that there will be a pressure drop if dispensing paste through a long tube - this could make dispensing more difficult.
- Do use a needle or nozzle large enough for the grade of paste. Nozzles should be at least 4 to 5 times larger in diameter than the maximum powder particle size.

Heating

- Do not heat the paste deposit directly with a flame. Heat the component if possible. Direct heating could result in the paste deposit being blown away or the flux being exhausted.
- Do expect fume from the binder when heating with induction or resistance equipment.
- Please read the Health and Safety data sheets before using any brazing or soldering products.

Automating the Process

- Do not let the process speed determine the brazing time.
- Like most brazing processes there is a need to let the flux do its job before the alloy can flow properly.
- Do consult a JM technical representative before buying an automated brazing system. This is to ensure that the system is compatible with paste.

General Information

- If used correctly, on a suitable application, paste can provide cost benefits.
- Do be aware that paste products are not generally cheaper than hard form alloy and flux.
- Do remember that not all brazing or soldering jobs are suitable for paste. Consult a JM technical sales representative and be prepared to carry out several sets of tests as paste often takes more than one attempt to get right.
- When brazing or soldering paste is used correctly many major manufacturers will testify to the effectiveness and cost savings they have made.

The JM Metal Joining Paste Product Range - Alloy Reference Chart

Soft Solder Alloys

	Composition						
Alloy	**Sn**	**Pb**	**Ag**	**Others**	**Melting Range °C**	**EN29453:1993**	**Availability**
JM1090	10	90	-	-	268-302	Alloy No 8	◇
JM3070	30	70	-	-	185-255	Alloy No 7	■
JM4060	40	60	-	-	183-235	Alloy No 5	■
JM5050	50	50	-	-	183-215	Alloy No 3	◇
JM6040	60	40	-	-	183-190	Alloy No 2	■
JM6236	62	36	2	-	178-190	Alloy No 30	■
JM6337	63	37	-	-	183	Alloy No 1	■
P5™	95	-	5	-	221-235	JM Specification	■
COMSOL™	5	93.5	1.5	-	296	Alloy No 34	■
P40™	96	-	4	-	221	Alloy No 28	■
97C	97	-	-	Cu 3	230-250	Alloy No 24	■
99C	99	-	-	Cu 1	230-240	Alloy No 23	■
LM10A™	87	-	10	Cu 3	214-217	JM Specification	■
A25	-	97.5	2.5	-	304	Alloy No 32	◇
Plumbsol™	97.5	-	2.5	-	221-225	JM Specification	■

Aluminium Brazing Alloys

	Composition						
Alloy	**Al**	**Si**		**Melting Range °C**	**AWS A5.8**	**EN 1044**	**Availability**
Alu-flo™ HT	88	12		575-585	BAlSi- 4	AL104	■
Alu-flo™ MT	86	10	4 Cu	520-585	BAlSi- 3	AL201	◇

Silver Copper Phosphorus Brazing Alloys

	Composition						
Alloy	**Ag**	**Cu**	**P**	**Melting Range °C**	**BS1845**	**EN 1044**	**Availability**
Sil-fos™ Plus	18	75	7	644	-	CP101	■
Sil-fos™	15	80	5	644-800**	CP1*	CP102	■
Sil-fos™ 6	6	87	7	644-718**	AWS 5.8 BCuP-4	-	■
Sil-fos™ 5	5	89	6	644-815**	CP4	CP104	■
Silbralloy™	2	91.7	6.3	644-825**	CP2*	CP105	■

Copper Phosphorus Brazing Alloys

	Composition							
Alloy	Ag	Cu	P	Others	**Melting Range °C**	**BS1845**	**EN 1044**	**Availability**
Copper-flo™		92.2	7.8		714-810**	CP3*	CP201	■
Copper-flo™ 2		92	6	2 Sb	690-825**	CP5	CP301	◇
Copper-flo™ 3		93.8	6.2		714-890**	CP6	CP203	◇
Stan-fos™		86.2	6.8	7 Sn	640-680		CP302	■

It is possible to manufacture most common brazing and soldering alloys in paste form. The following reference charts show the range of Johnson Matthey alloys. The charts indicate whether an alloy is available as a standard ■ or special ◇ product line.
Special order products will be subject to minimum order quantities or values.

This chart is intended for reference purposes only. Not all alloys are available. Please consult Johnson Matthey for more details.
Easy-flo® and Silver-flo® are registered to JM in the EU.
* Not an exact equivalent. ** In use, the working melting range for these alloys is lower than the liquidus of the alloy.

Silver Brazing Alloys - Cadmium Free

	Composition							
Alloy	**Ag**	**Cu**	**Zn**	**Sn/Si**	**Melting Range °C**	**BS1845**	**EN 1044**	**Availability**
Silver-flo® 67E	67	23	10		705-723			
Silver-flo® 60	60	26	14		695-730	AG 13	AG202	
Silver-flo® 55	55	21	22	2 Sn	630-660	AG 14	AG103	
Silver-flo® 56	56	22	17	5 Sn	618-652	(AWS 5.8 Bag7)	AG102	
Silver-flo® 56S	56	22	17	4.8 Sn, 0.2Si	618-652	JM Specification		
Silver-flo® 452	45	27.5	25	2.5 Sn	640-680		AG104	
Silver-flo® 453S	45	25	26.8	3 Sn, 0.2 Si	640-680	JM Specification		
Silver-flo® 45	45	25	30		680-700	JM Specification		
Silver-flo® 44	44	30	26		675-735		AG203	
Silver-flo® 40	40	30	28	2 Sn	650-710	AG 20	AG105	
Silver-flo® 34	34	36	27.5	2.5 Sn	630-730		AG106	
Silver-flo® 33	33	33.5	33.5		700-740			
Silver-flo® 302	30	36	32	2 Sn	665-755	AG 21	AG107	
Silver-flo® 30	30	38	32		695-770		AG204	
Silver-flo® 25	25	40	35		700-790		AG205	
Silver-flo® 24	24	43	33		740-800			
Silver-flo® 20	20	44	36	0.15 Si	776-815		AG206	
Silver-flo® 18	18	45.75	36	0.25 Si	784-816			
Silver-flo® 16	16	50	34		790-830			
Silver-flo® 12	12	48	40		800-830		AG207	
Silver-flo® 5	5	55	40	0.15 Si	820-870		AG208	
Silver-flo® 4	4	56	39.7	0.3 Si	870-890			
Silver-flo® 2	2	57.9	40	0.1 Si	880-890			
Silver-flo® 1	1	60	39	0.1 Si	890-900			

Silver Brazing Alloys - Cadmium Bearing

	Composition							
Alloy	**Ag**	**Cu**	**Zn**	**Cd**	**Others**	**Melting Range °C**	**BS1845**	**EN 1044**	**Availability**
Easy-flo®	50	15	16	19		620-630	AG1	AG301	
Easy-flo® 2	42	17	16	25		608-617	AG2	AG303	
Easy-flo® No. 3	50	15.5	15.5	16	3Ni	634-656	AG9	AG351	
DIN Argo-flo™	40	19	21	20		595-630		AG304	
Mattibraze™ 35	35	25	21	18		610-700		AG305	

Silver Brazing Alloys - Special

	Composition								
Alloy	**Ag**	**Cu**	**Zn**	**Cd**	**Others**	**Melting Range °C**	**BS1845**	**EN 1044**	**Availability**
Argo-braze™ 562	56	42			2 Ni	771-893	B Ag-13a, AMS 4765		
Argo-braze™ 502	50	20	28		2 Ni	660-750	(AWS BAg-24)		
Argo-braze™ 72/72V*	72	28				778	AG7V	AG401	
Argo-braze™ 64	64	26			2Ni, 2 Mn,6In	730-780	JM Specification		
Argo-braze™ 63	63	28.5			2.5 Ni, 6 Sn	691-802	B Ag-21, AMS 4774		
Argo-braze™ 63V	63	27			10 In	685-730	-	-	
Argo-braze™ 61V	61	24			15 In	630-705	-	-	
Argo-braze™ 60/60V**	60	30			10 Sn	602-718	B Ag-18, AMS 4773		
Argo-braze™ 56	56	27			2.5 Ni, 14.5 In	600-711		AG403	
Argo-braze™ 54***	54	40	5		1 Ni	718-857	B Ag-13, AMS 4772		
Argo-braze™ 49H	49	16	23		7.5 Mn, 4.5 Ni	680-705	AG18	AG502	
Argo-braze™ 49LM	49	27.5	20.5		2.5 Mn, 0.5 Ni	670-710			
Argo-braze™ 40	40	30	28		2 Ni	670-780	(AWS BAg-4)		
Active-braze™ No. 1	92.75	6			1.25 Ti	800-900			
Active-braze™ No. 2	68.8	26.7			4.5 Ti	830-850			

*Formerly known as Silver-Copper Eutectic, **Formerly known as RTSN, ***Formerly known as DHE 310

The JM Metal Joining Paste Product Range - Alloy Reference Chart

Base Metal/Copper Based Brazing Alloys

	Composition							
Alloy	**Cu**	**Others**			**Melting Range °C**	**BS1845**	**EN 1044**	**Availability**
Copper	99Cu				1081	CU5	CU101	
94/6 Copper-Tin	94Cu	6Sn			945-1065	-	-	
B Bronze™	97Cu	3Ni	0.02B		1081-1101	CU7	CU105	
C Bronze™	86.5Cu	11Mn	2.5 Ni		965-995	-	-	
D Bronze™	86Cu	10Mn	4Co		980-1030	-	-	
F Bronze™	58Cu	2Mn	2Co	38 Zn	890-930	-	-	
Argentel™ No.1	60Cu	40Zn	0.2Si		875-895	CZ6	CU301	
Argentel™	48Cu	42Zn	10Ni		890-920	CZ8	CU305	

Palladium Based Brazing Alloys

	Composition							
Alloy	**Pd**	**Ag**	**Cu**	**Ni**	**Melting Range °C**	**BS1845**	**EN 1044**	**Availability**
Pallabraze™ 810	5	68.5	26.5	-	807-810	PD1V	PD106	
Pallabraze™ 840	10	67.5	22.5	-	834-840	PD3V	PD104	
Pallabraze™ 850	10	58.5	31.5	-	824-850	PD2V	PD105	
Pallabraze™ 880	15	65	20	-	856-880	PD4V	PD103	
Pallabraze™ 900	20	52	28	-	876-900	PD5V	PD102	
Pallabraze™ 950	25	54	21	-	901-950	PD6V	PD101	
Pallabraze™ 1010	5	95	-	-	970-1010	PD7V	PD204	
Pallabraze™ 1090	18	-	82	-	1080-1090	PD8V	PD203	

Gold Based Brazing Alloys

	Composition								
Alloy	**Au**	**Cu**	**Ni**	**Others**	**Melting Range °C**	**BS1845**	**AMS/AWS A5.8**	**EN 1044**	**Availability**
Orobraze™ 910	80	19	-	1 Fe	908-910	AU1V	-	AU101	
Orobraze™ 940	62.5	37.5	-	-	930-940	AU2V	-	AU102	
Orobraze™ 950	82	-	18	-	950	AU5V	4787/BAu-4	AU105	
Orobraze™ 970	50	50	-	-	955-970	-	-	-	
Orobraze™ 990	75	-	25	-	950-990	AU6V	-	AU106	
Orobraze™ 998	37.5	62.5	-	-	980-998	AU3V	BAu-1	AU103	
Orobraze™ 1005	35	65	-	-	970-1005	-	-	-	
Orobraze™ 1018	30	70	-	-	996-1018	AU4V	-	AU104	
Orobraze™ 1030	35	62	3	-	1000-1030	-	BAu-3	-	
Orobraze™ 1040	70	-	-	30 Ag	1030-1040	-	-	-	

Nickel Based Brazing Alloys

	Composition									
Alloy	**Ni**	**Cr**	**Fe**	**B**	**Others**	**Melting Range °C**	**BS1845**	**AMS/AWS A5.8**	**EN 1044**	**Availability**
Nickelbraze HTN1	Bal	14	4.5	3.1	Si 4.5,C 0.7	980-1060	HTN1	4775/BNi-1	NI101	
Nickelbraze HTN1A	Bal	14	4.5	3.1	Si 4.5	980-1070	HTN1A	4776/BNi-1a	NI1A1	
Nickelbraze HTN2	Bal	7	3.0	3.1	Si 4.5	970-1000	HTN2	4777/BNi-2	NI102	
Nickelbraze HTN3	Bal	-	0.5	3.1	Si 4.5	980-1040	HTN3	4778/BNi-3	NI103	
Nickelbraze HTN4	Bal	-	1.5	1.8	Si 3.5	980-1070	HTN4	4779/BNi-4	NI104	
Nickelbraze HTN5	Bal	19	-	-	Si 10.1	1080-1135	HTN5	4782/BNi-5	NI105	
Nickelbraze HTN6	Bal	-	-	-	P 11	875	HTN6	BNi-6	NI106	
Nickelbraze HTN7	Bal	14	-	-	P 10.1	890	HTN7	BNi-7	NI107	

The Environment, Health and Safety

The Environment

The use of lead and cadmium in products is increasingly recognised as being undesirable both in terms of the long-term environmental impact and recyclability of products.

The End of Life Vehicles (ELV) Directive (2000/53/EC), the RoHS Regulations in Directive (2002/95/EC) and WEEE Directive on waste electrical and electronic equipment (2002/96/EC) prevent the use of certain hazardous substances including cadmium and lead containing materials. The use of lead in potable water systems has also been prohibited in Europe and in many countries worldwide.

Health and Safety in Soldering and Brazing

Soldering and brazing are firmly established throughout the world as reliable, simple and safe methods of joining metal components. However, as both processes entail the raising of components to elevated temperatures and the use of molten alloys and chemical fluxes that contain volatile constituents, regard must be paid to safety precautions when soldering or brazing. Johnson Matthey Metal Joining issue full material safety datasheets and offer general guidelines on health and safety in soldering or brazing. Please consult the Johnson Matthey Technical Department for advice on health and safety in soldering or brazing.

Lead and Cadmium Containing Products

Health and safety issues associated with the incorrect use of cadmium containing filler metals and disposal of lead and cadmium containing products are also widely recognised.

Johnson Matthey recommends cadmium-free and lead-free products wherever possible. Unless a sound technical reason exists for doing otherwise we will not recommend the use of cadmium or lead containing materials.

Please consult the Johnson Matthey Technical Department for advice on cadmium or lead free products.

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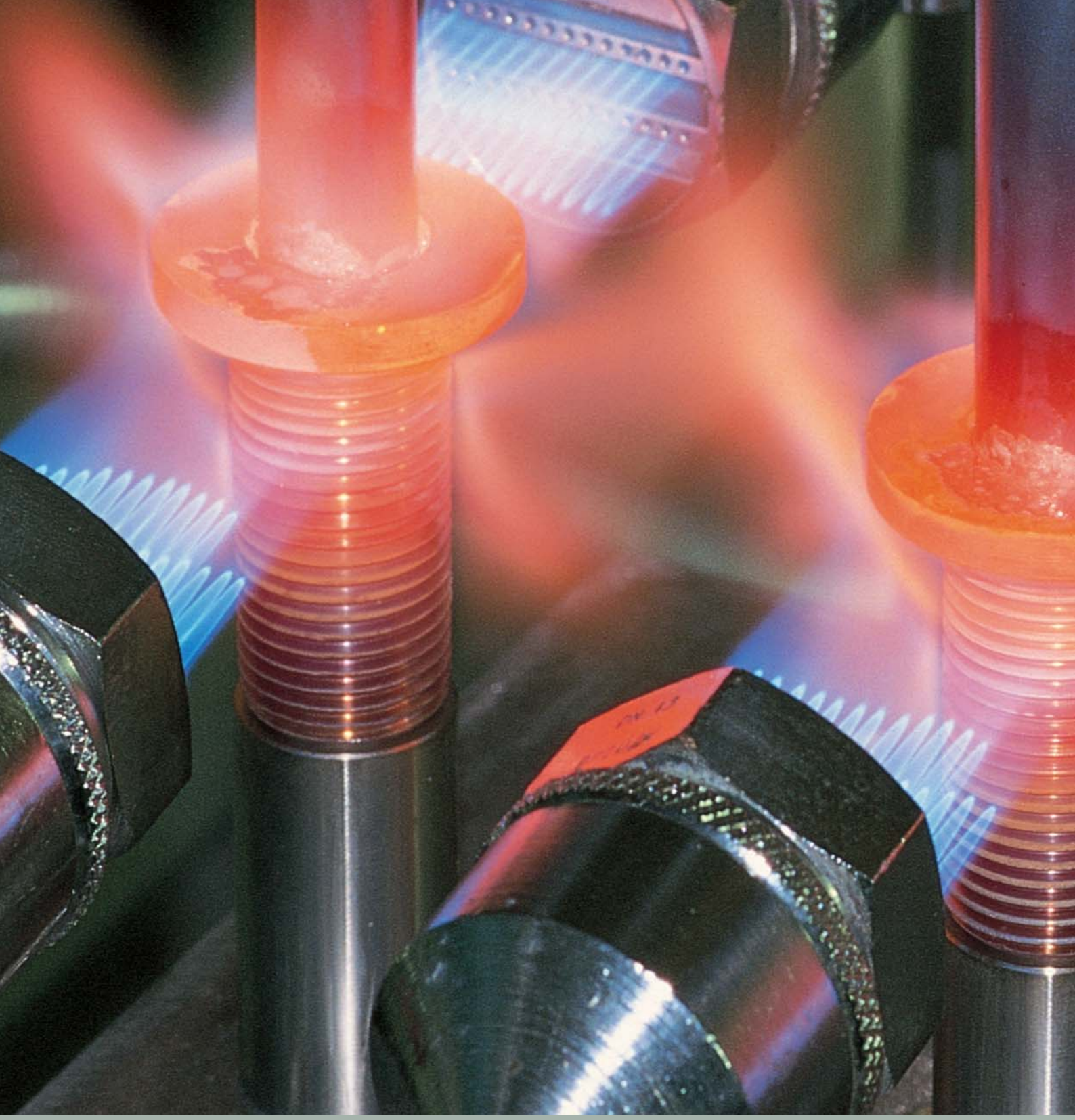

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