

Don't skimp on the silver

Whenever the price of silver rises sharply on the exchanges, fabricators are tempted to review the cost-effectiveness of brazing as a joining technique.

Generally, they will not compare brazing with other joining methods — welding, gluing — except in extreme cases. Brazing's joint strength and fast application continue to make it attractive.

More often than not then, fabricators will consider moving to lower silver content alloys. These generally have higher melting points than their high silver equivalents and are often less fluid, but they are considerably cheaper and instantly appeal to financial directors as a low cost option.

Most financial directors, however, fail to include more than the consumable cost in their calculations when introducing new alloy.

A closer look at the cost advantages and disadvantages should consider not only this factor but also the amount of alloy laid down to make a successful joint, the brazing time (ie, the time required to heat the joint to brazing temperature) and the energy costs involved.

User appeal

Undoubtedly most popular with brazing operators are the high silver content, low melting point alloys.

Many operators believe that the easy flow obtainable with high silver alloys means that they can make sound joints with less alloy.

The only way to decide whether this was true was to conduct tests asking a number of operators to make the same joint with a number of different alloys, and to compare the times taken and the amount of alloy put down.

The brazed joint used for the study was a simple capillary between two tubes in brass or steel — typical of a wide variety of brazed assemblies. All joint faces were degreased before brazing, and unmachined surfaces mechanically cleaned.

Brazing was carried out by three operators using oxy-acetylene torches. Alloy was applied in the form of hand fed rod, generally 1.5 mm dia; the weight applied was measured by weighing the rod before and after brazing.

In all cases tensile specimens showed satisfactory results whatever the alloy used. Here are the main economic conclusions of the study.

Alloy application

With low melting point, high silver content alloys there was a tendency to use less brazing alloy to make the joint.

In fact, the use of these alloys allowed much smaller joint gaps to be employed, reducing

Low silver content brazing alloys may look attractive when stock market speculators send the silver price skywards. But an economic study shows that they may prove a false economy

the amount wasted in forming a "fillet" and reducing even further the total amount of alloy applied.

It was important to select the correct size of rod. If the rod diameter was too large then too much alloy was applied by the operators, even if they were aware that they should limit the amount.

Poorer flow was found with too large a rod diameter making it easy to apply too much. On the other hand too small a rod diameter could sometimes result in too much fluidity and occasional difficulty in bridging the joint gap.

For most effective brazing, rod size should be gauged against the size of the gap to be bridged.

Time

As alloy melting point increases, brazing time also rises.

Interestingly, the higher the liquidus temperature the more dramatically is brazing time raised. An example from the study showed that for an increase of liquidus temperature of 34% brazing time rises 42%*.

The bigger the component the longer it will have to be heated to reach the higher brazing temperature and the more sensible it becomes to buy lower melting point alloys with lower operating temperatures.

Lower alloy consumption combined with shorter heating times can mean *actual savings* compared with the higher melting point, apparently "cheaper" alloys.

Post brazing cleaning times

Another benefit of the lower melting alloys is found when post brazing cleaning operations are taken into account.

Low temperature fluxes are readily soluble in water provided they have not been exhausted by overheating.

If the alloy liquidus temperature is below

800°C then water-soluble fluxes can probably be used, simplifying cleaning procedures and reducing times taken.

Also the "burning" of the metal that can occur away from the fluxed joint is substantially increased at higher temperatures, presenting problems in finishing operations like plating.

Cadmium-containing alloys

The great fluidity of cadmium-bearing alloys can significantly reduce the brazing time. Although liquidus temperature may be higher than some silver alloys, the greater fluidity means faster brazing.

However, to use these alloys presents hidden costs. For, while they are more economic than their cadmium-free equivalents, they give rise to cadmium oxide in the brazing operator's breathing zone. A danger exists that the concentration (in number of parts per million of this compound in the breathing zone) will exceed the threshold limit laid down in health and safety codes.

Therefore, if cadmium-containing alloys are chosen an efficient fume extractor must be installed — and this can be a considerable capital expense.

Joint integrity is very important, of course, and while all alloys tested in the trials are capable of producing strong, leak-tight joints the ease with which the joints are made increases as melting point decreases. As well as the greater fluidity of the high silver cadmium content alloys, this reflects the problems in achieving an even heat pattern and avoiding flux exhaustion at high temperatures.

Low brazing temperatures are often essential when brazing heat treated alloys, and may be demanded on copper and brass to avoid excessive softening and grain growth.

False economy

It is clear that estimation of costs for brazing a particular joint is not just a matter of estimating the cost of the consumables.

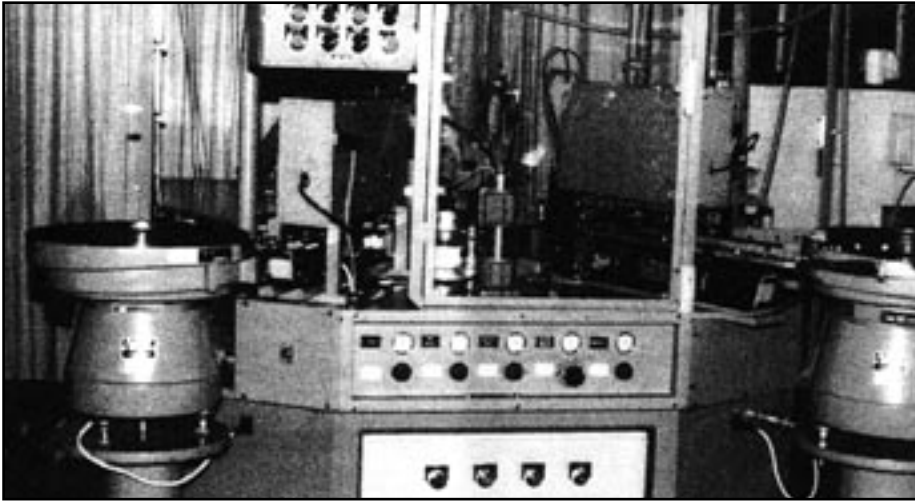
Fuel costs for heating and excessive application of alloy can mean that what is saved on the silver is lost when the joint is being made.

Of course, there are occasions when less free-flowing alloys are advantageous — when for example a large joint gap has to be bridged, but generally the switch can be a false economy.

The conclusions in this paper are drawn from an in-house study by Johnson Matthey Metals, Harlow. Further details of the test data can be obtained from Mr D. R. Totty, manager, sales technical services, Metal Joining Group.

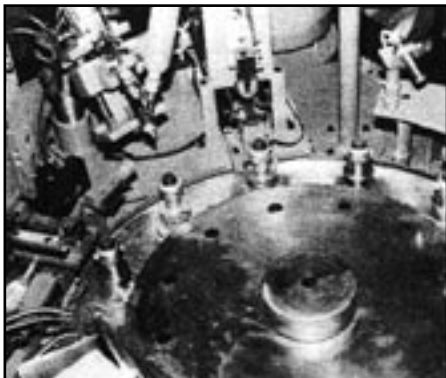
* Comparing two Johnson Matthey alloys, Easy-flo No. 2 (high silver and Silver-flo 16 (lower silver).

Different materials — same process



Front view of machine for automatic brazing of seals/bearings, showing the two bowl feeders

Bird's eye view of the rotary table. Fixtures visible, from the left, are in positions for boss placing, braze paste application, ring placing, blank, and first heating station



Many forms of brazing machine are manufactured by Johnson Matthey Metals, offering different levels of automation and including shuttle, continuous rotation and rotary indexing machines, as well as a wide range of brazing alloys, fluxes and brazing pastes.

The one illustrated was seen at the factory immediately before shipping to the customer in Denmark — a large manufacturer of submersible water pumps.

It is a rotary indexing machine designed to braze nine different seals/bearings; the operation is brazing tungsten carbide rings on to brass and two different stainless steel bosses, and will replace what is currently a mainly manual system.

The whole system is controlled by a microprocessor — which can communicate with others in the plant — and can be quickly re-programmed for any of the nine component assemblies. An interesting point is that the same process and braze paste is used for all assemblies, including the different metals. Performance of the machine is 9.5 to 15 assemblies per minute, according to type.

Braze paste

Brazing alloys in paste form are homogeneously blended mixtures of brazing alloy powder and binder; they have flux for brazing in air, or no flux for brazing under atmosphere or vacuum.

Pastes are applied by applicator systems, hand held, or high speed automatic as in the machine described. Claims for pastes include increased productivity, controlled use of alloy and flux, consistency and improved work conditions — compared with wire and separate flux.

In this application cadmium-free Siver-flo 55 is used; it is 55Ag:Cu:Zn:Sn, with flux. Melting point is 630-660°C.

There are 12 fixtures on the rotary table and 12 operation stations. Bosses are supplied in bulk to a vibratory bowl feeder which presents them in the correct orientation to a straight feeder and to the fixture. At the next station braze paste is applied, and at the next the tungsten carbide ring is placed on using another bowl feeder and pick-and-place device.

The components pass through a blank station before reaching the heating stations, of which there are three. They employ low noise, high efficiency gas burners; the first two have two burner heads and the third station three heads. Each head develops 6500-8000 Btu/hr.

At the third heating station, a device known as a “bonker” comes down to seat the ring firmly in position on the boss.

The remaining stations are a blank for air consolidation, a forced air cooling station, unloading station using a further pick-and-place device, water cooling of the fixtures, and finally air drying of the fixtures before the next cycle.

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